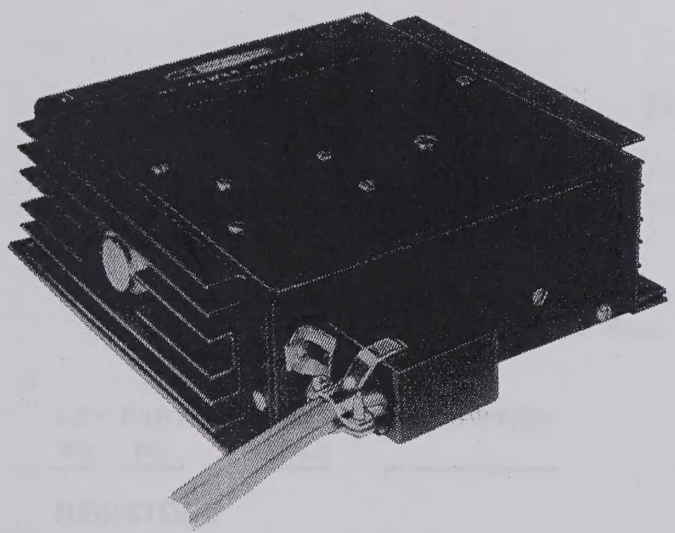
HTH PWR SPLY HP-13B

CONDENSED

Assembly and Operation of the HEATHKIT TRANSISTORIZED DC POWER SUPPLY

MODEL HP-13B



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HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

Assembly and Operation of the

TRANSISTORIZED DC POWER SUPPLY

MODEL HP-139

INTRODUCTION

The Heathkit Model HP-13B Transistorized DC Power Supply was designed to furnish all necessary operating power for Heathkit Mobile Amateur Transmitters, Transceivers, and Receivers, as well as for other brands of mobile equipment.

This Power Supply is actually three DC power sources in one unit. It provides high voltage (750 volts), low voltage (300 or 250 volts), and bias voltage (—130 volts). It also switches DC filament voltage for the equipment with which it is used.

Circuit features include relay control of all primary power, plus individual circuit breaker protection of the DC input to the Power Supply and of the DC filament voltage line to the equipment used with the Power Supply. The circuit breakers are the automatic reset, load delay type. They insure positive protection for all equipment involved in case of an overload or accidental short circuit.

The power transformer, an epoxy encapsulated toroid unit is of advanced design, assuring maximum efficiency. This transformer, in conjunction with the power transistors used as a DC-to-AC converter, provides a high frequency switching rate along with high power and instant starting. Specially designed heat sink assemblies provide maximum transistor cooling.

Efficient, long life silicon rectifiers and heavy-duty filter capacitors, mounted on a rugged circuit board, provide trouble-free rectification and filtering.

Because the complete Power Supply is physically small, it requires a minimum of mounting space. Under-the-hood mounting is recommended.

Read the "Kit Builders Guide" for complete information on unpacking, parts identification, tools, wiring, soldering, and step-by-step assembly procedures.

PARTS LIST

Check each part against the following list. The key numbers correspond to numbers on the Parts Pictorial (fold-out from Page 3).

To order replacement parts use the Parts Order Form furnished with this kit. If a Parts Order Form is not available, refer to the "Parts Replacement" inside the rear cover of the Manual.

Any part that is packaged in an individual envelope with a part number on it should be placed back in its envelope after it is identified, until that part is called for in a step.

RESISTORS

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
A1	1-3-1	1	3300 Ω (orange-orange-red), 1-watt	.10
A1	1-46-1	1	27 kΩ (red-violet-orange), 1-watt	.10
A2	1-15-2	1	1000 Ω (brown-black-red), 2-watt	.15
A2	1-24-2	3	100 kΩ (brown-black-yellow), 2-watt	.15
A3	3-1-24	2	4 Ω, 24-watt, ceramic	.95

CAPACITORS

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
B1	21-35	3	.005 μF 1.6 kV disc	.15
B2	25-254	2	4 μF electrolytic	.50
B3	25-206	1	20-20 μF electrolytic	.85
B4	25-207	5	20 μF electrolytic	.85
B4	25-28	1	100 μF electrolytic	.60
B5	27-20	1	.4 μF Mylar*	.30

*DuPont Registered Trademark

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
CIRCUIT BREAKERS-RELAY-CHOKES-TRANSFORMER				
C1	65-20	1	10-ampere circuit breaker	.80
C1	65-16	1	40-ampere circuit breaker	.80
C2	69-68	1	12-volt relay	5.00
C3	45-59	1	Suppression choke	.60
C4	46-24	1	Filter choke	1.30
C5	54-144	1	Power transformer	27.95
DIODES-TRANSISTORS				
D1	57-27	7	Silicon diode, 600V, 1A (1N2071)	.50
D1	57-42	1	Silicon diode, 100V, 3A (3A1)	1.15
D2	417-120	2	Power transistor	5.00
FUSEHOLDER-PLUG-CABLE CONNECTOR				
E1	423-10	1	In-line fuseholder	.50
E2	432-34	1	15-contact plug	1.20
E3	432-35	1	15-contact connector	2.10
METAL PARTS				
F1	200-633-1	1	Chassis	2.50
F2	204-549	1	Circuit breaker mounting bracket	.15
F3	205-417-1	1	Bottom plate	.85
F4	215-11-1	2	Heat sink (bottom section)	.60
F5	215-12-1	2	Heat sink (middle section)	.25
F6	215-13-1	4	Heat sink (top section)	.15
HARDWARE				
#6 Hardware				
G1	250-235	8	6-32 x 1/4" screw	.05
G2	250-233	12	6-32 x 3/8" screw	.05
G3	250-234	10	6-32 x 1/2" screw	.05
G4	250-364	2	6-32 x 7/8" screw	.05
G5	250-237	4	#6 x 3/8" sheet metal screw	.05
G6	252-77	24	6-32 nut	.05
G7	253-96	2	#6 flat washer	.05
G8	254-25	26	#6 lockwasher	.05
G9	259-1	4	#6 solder lug	.05
G10	255-23	4	#6 threaded spacer	.05

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
#10 Hardware				
G11	250-83	4	#10 x 1/2" sheet metal screw	.05
G12	252-63	8	10-32 nut	.05
G13	253-3	4	#10 fiber flat washer	.05
G14	253-7	4	#10 fiber shoulder washer	.05
G15	254-36	1	#10 lockwasher	.10
G16	259-5	4	#10 solder lug	.05
MISCELLANEOUS				
	85-78-2	1	Circuit board	1.80
H1	259-15	1	Hook type solder lug	.05
H2	259-20	2	Circuit board solder terminal	.05
H3	262-8	9	Circuit board solder pin	.05
H4	259-21	2	5/16" solder lug	.05
H5	260-32	2	Cable connector clip lock	.30
	344-2	1	Black wire	.05/ft
	346-2	1	Large sleeving	.05/ft
	347-13	1	2-wire cable	.15/ft
	347-52	1	8-wire cable	.60/ft
	421-13	1	1/2-ampere fuse	.15
	490-5	1	Nut starter	.10
	391-34	1	Blue and white identification label	
	597-260	1	Parts Order Form	
	597-308	1	Kit Builders Guide	
		1	Manual (See front cover for part number.)	2.00
			Solder (Additional 3' rolls of solder, #331-6, can be ordered for 15 cents each.)	

The above prices apply only on purchases from the Heath Company where shipment is to a U.S.A. destination. Add 10% (minimum 25 cents) to the price when ordering from a Heathkit Electronic Center to cover local sales tax, postage, and handling. Outside the U.S.A. parts and service are available from your local Heathkit source and will reflect additional transportation, taxes, duties, and rates of exchange.

( ) Blue lead to the circuit board pin marked BLUE (S-1).

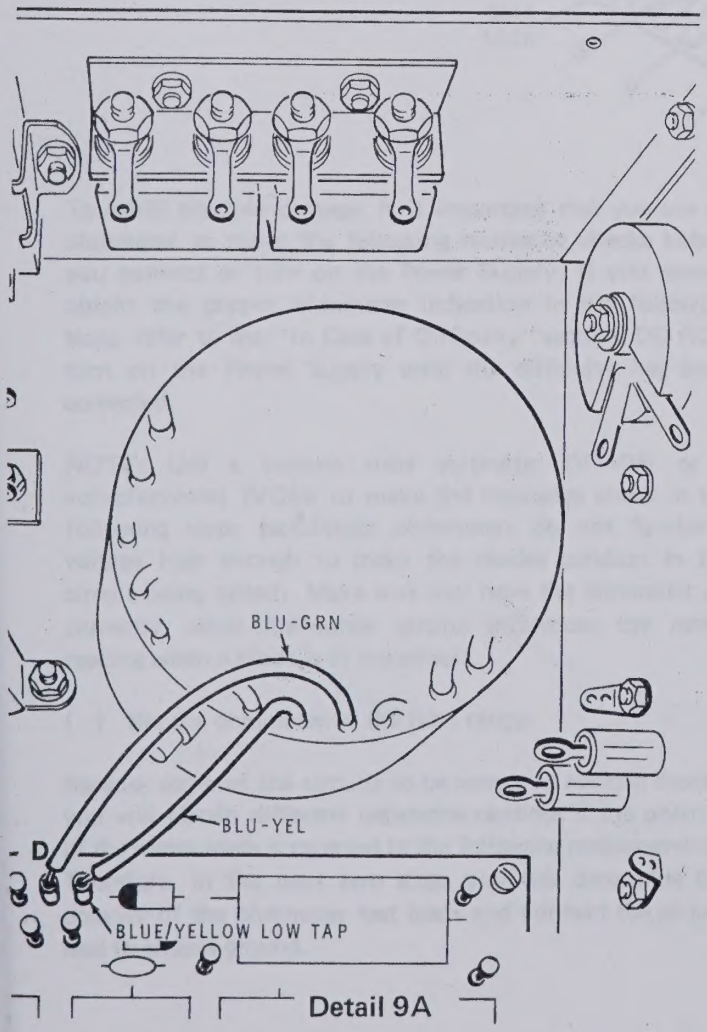
( ) 6" gray lead to the circuit board pin marked BIAS (S-2).

( ) Green-yellow lead to lug 2 of transistor AE (S-1).

( ) Green lead to lug 1 of resistor AH (S-2). Wrap this lead around the resistor lug.

( ) Carefully inspect the lugs of the resistors at CB and AH. Make sure the lugs do not touch the screws at CC and AG respectively.

IMPORTANT: The low voltage output circuit has two voltage values available. The low tap output is 250 volts DC. The high tap output is 300 volts DC. Determine which of these voltages is required for the equipment with which you plan to use the Power Supply. Then proceed to the steps for the voltage value you have selected. Terminal D on the circuit board is a "dummy" terminal. (Make sure the leads are soldered to the terminals and that the terminals are soldered to the circuit board.)



Detail 9A

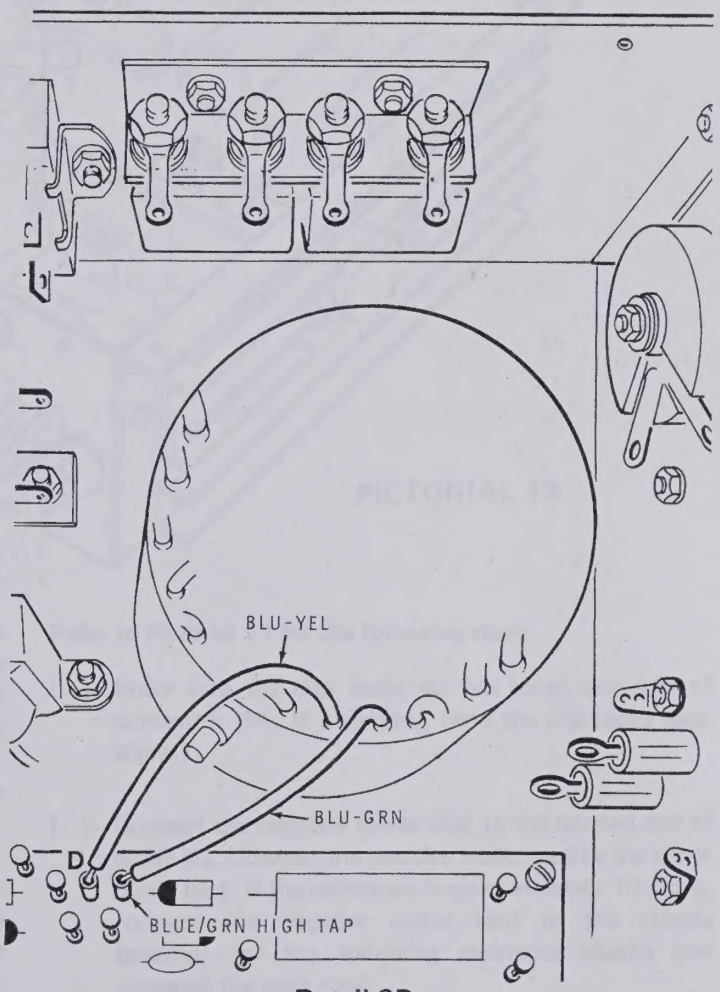
For 250-Volt DC Output

Refer to Detail 9A for the following steps.

( ) Blue-yellow lead to the solder terminal marked BLUE/YELLOW LOW TAP (S-1).

( ) Blue-green lead to the solder terminal marked D (S-1).

Proceed to "Cable Preparation."



Detail 9B

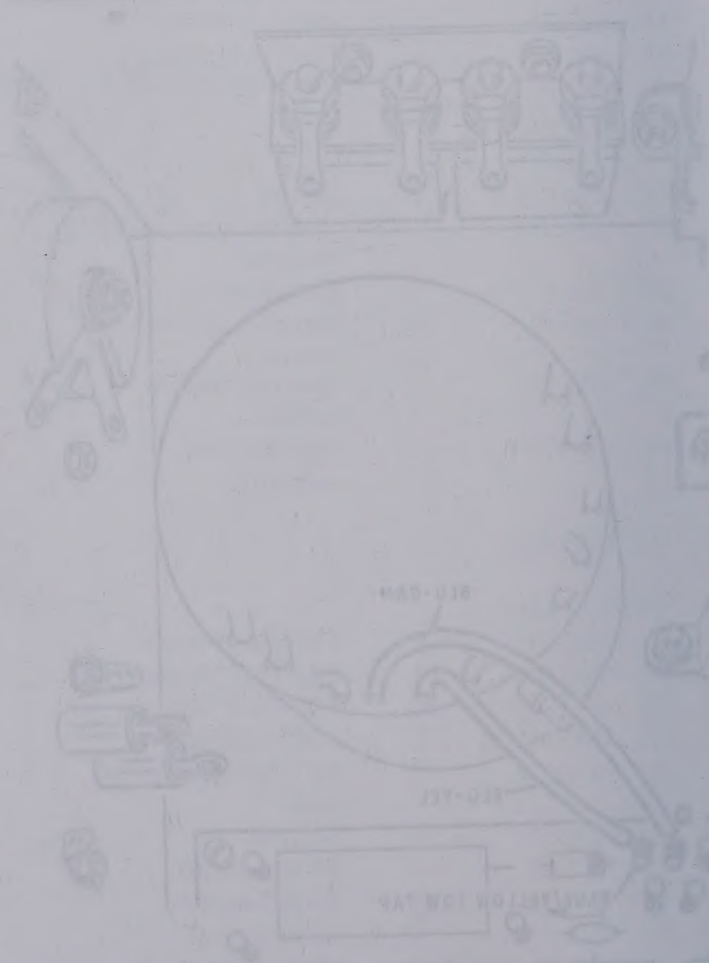
For 300-Volt DC Output

Refer to Detail 9B for the following steps.

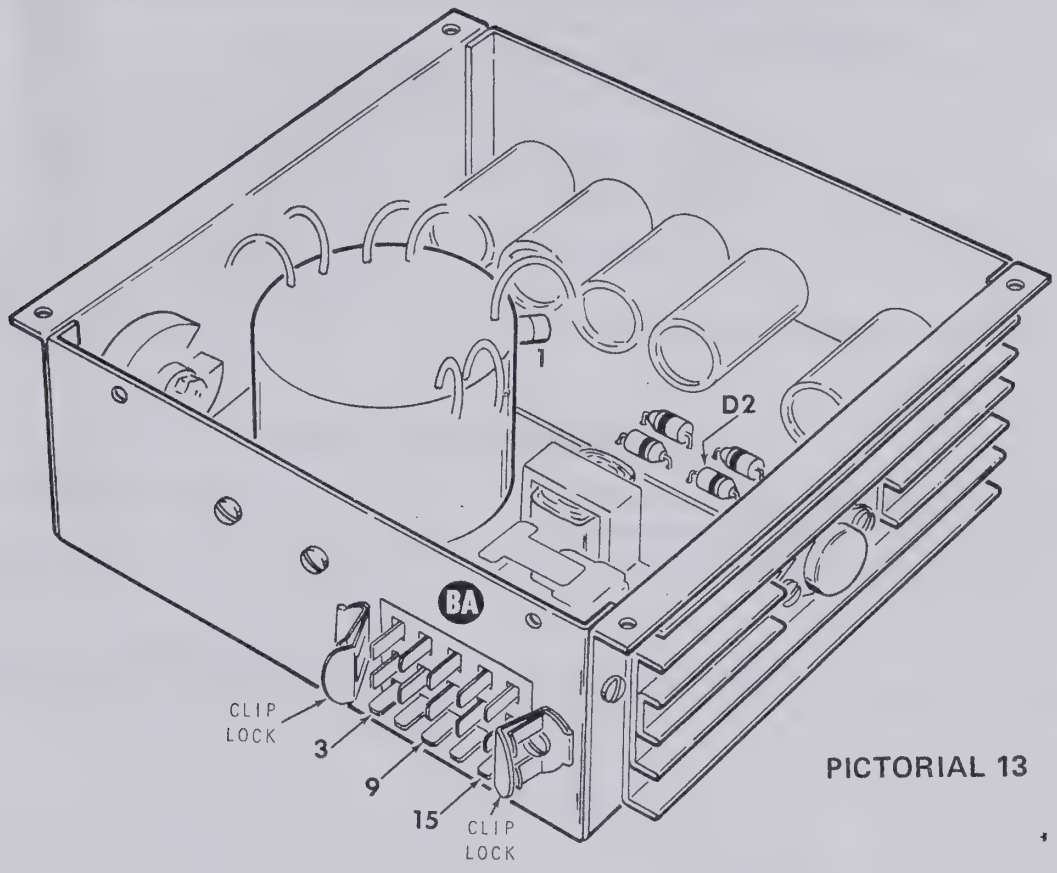
( ) Blue-green lead to the solder terminal marked BLUE/GRN HIGH TAP (S-1).

( ) Blue-yellow lead to the solder terminal marked D (S-1).

Proceed to "Cable Preparation."



INITIAL TESTS



PICTORIAL 13

To avoid possible damage, it is important that you use an ohmmeter to make the following resistance checks before you connect or turn on the Power Supply. If you cannot obtain the proper ohmmeter indication in the following steps, refer to the "In Case of Difficulty" section. DO NOT turn on the Power Supply until the difficulty has been corrected.

NOTE: Use a vaccum tube voltmeter (VTVM) or a volt-ohmmeter (VOM) to make the resistance check in the following steps (solid-state ohmmeters do not furnish a voltage high enough to make the diodes conduct in the circuit being tested). Make sure you have the ohmmeter set correctly, since the range setting influences the meter reading when a diode is in the circuit.

( ) Set the ohmmeter to the RX1 range.

Because some of the circuits to be measured contain diodes, you will obtain different resistance readings if the polarity of the meter leads is reversed in the following measurements. Therefore, in the next two steps you will determine the polarity of the ohmmeter test leads and connect the proper lead to chassis ground.

Refer to Pictorial 13 for the following steps.

( ) Make sure the clip locks do not touch any lugs of connector BA. If necessary, bend the clip locks back slightly.

( ) Connect the negative meter lead to the banded end of diode D2. Connect the positive meter lead to the other diode lead. If the resistance is approximately 10 ohms, connect the negative meter lead to the chassis (ground) for the following resistance checks and disregard the next step.

( ) If the meter needle remains on or near the infinity mark (full scale), reverse the meter leads. If you now obtain a reading of approximately 10 ohms, connect the positive meter lead to the chassis (ground) for the following resistance checks.

Make the resistance checks in the following chart from chassis ground to the indicated points. Some of the readings will take a few seconds to reach the specified resistance because of the slow charging rate of the capacitor in the Power Supply.

DO THIS:	THE RESISTANCE SHOULD BE:
( ) Measure terminal 1 on the transformer.	25 Ω or greater.
( ) Set the ohmmeter to the RX10k range.	
( ) Measure pin 3 of connector BA.	100 kΩ or greater.
( ) Measure pin 15 of connector BA.	200 kΩ or greater.
( ) Reverse the ohmmeter leads.	
( ) Measure pin 9 of connector BA.	25 kΩ or greater.
( ) Disconnect the ohmmeter leads.	

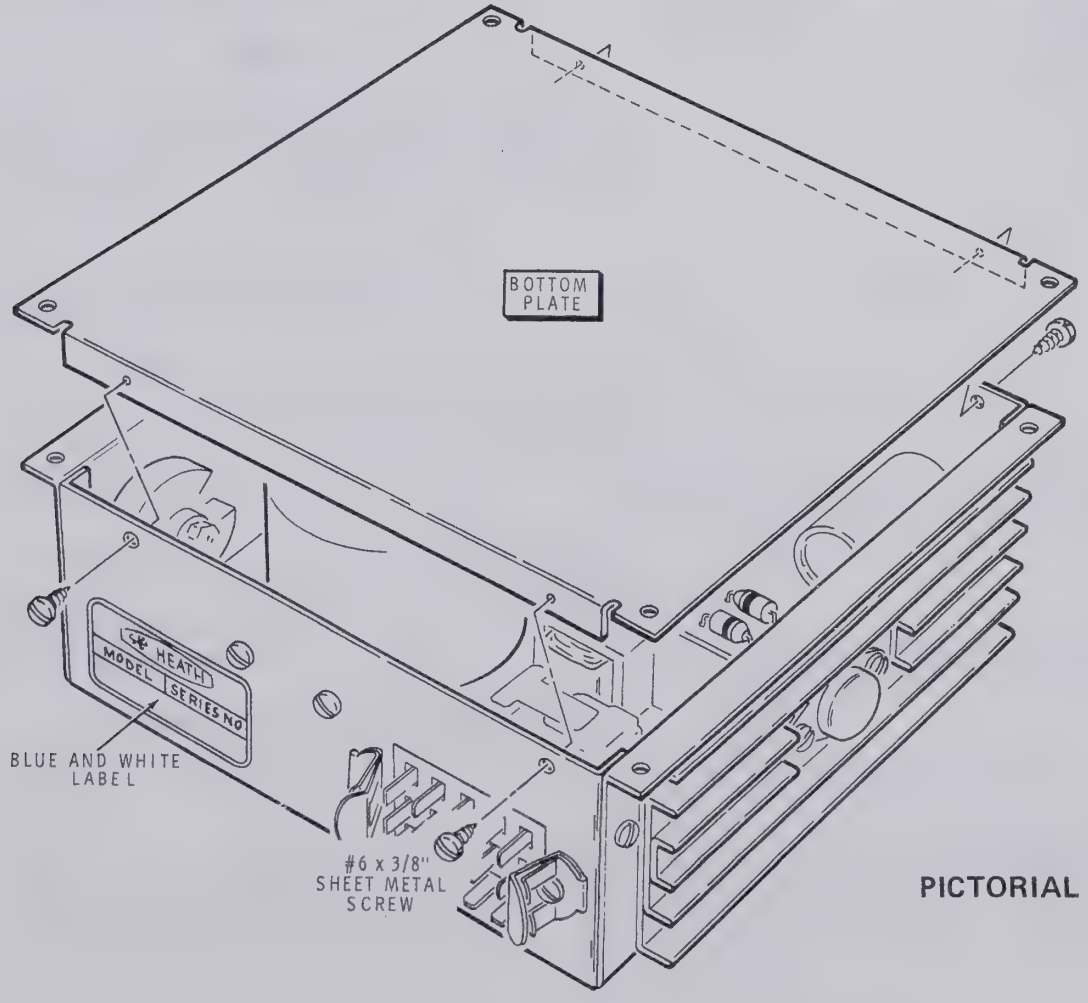
FINAL ASSEMBLY

Refer to Pictorial 14 for the following steps.

( ) Install the bottom plate on the chassis. Use four #6 x 3/8" sheet metal screws.

( ) Carefully peel away the paper backing from the blue and white identification label. Then press the label on the chassis at the location shown. Be sure to refer to the numbers on this label in any communications you have with the Heath Company about this kit.

This completes "Final Assembly." Proceed to "Installation."



PICTORIAL 14

INSTALLATION

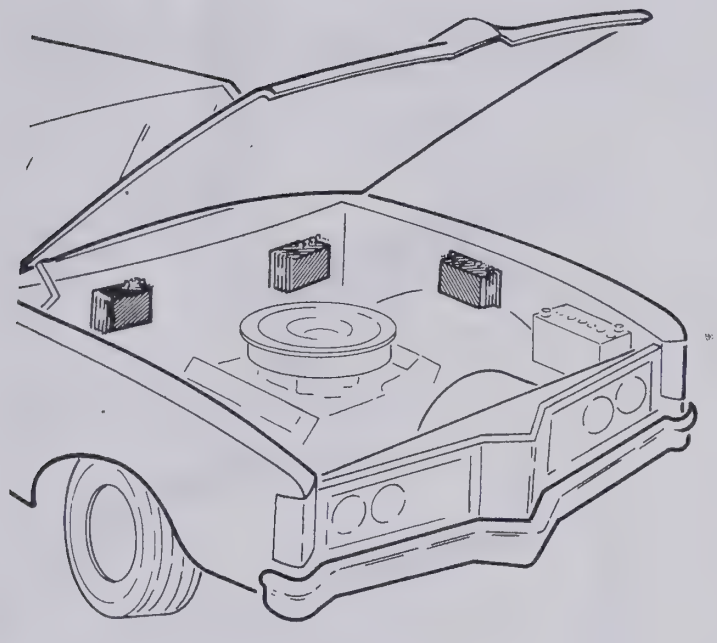


Figure 1

WARNING: Before you install this Power Supply in a vehicle, measure the generator or alternator output voltage. The voltage output of the charging system MUST NOT EXCEED 16 VOLTS.

MOUNTING CONSIDERATIONS

It is recommended that you mount the Power Supply under the hood. Figure 1 shows several possible under-the-hood mounting locations. Choose the location that is best for your particular installation and allows adequate ventilation and protection from water spray.

Mount the Power Supply as near to the vehicle battery or starter solenoid as practical. This will allow the 2-wire battery cable to be connected to either of these two points by the shortest route possible.

It is preferable that you mount the Power Supply with the heat sink fins vertical to provide maximum cooling of the transistor. However, this is not mandatory.

( ) When you have decided upon the mounting position, use the Power Supply as a template and mark the four hole locations on the chassis. See Figure 2. Drill a 9/64" hole at each of these four points.

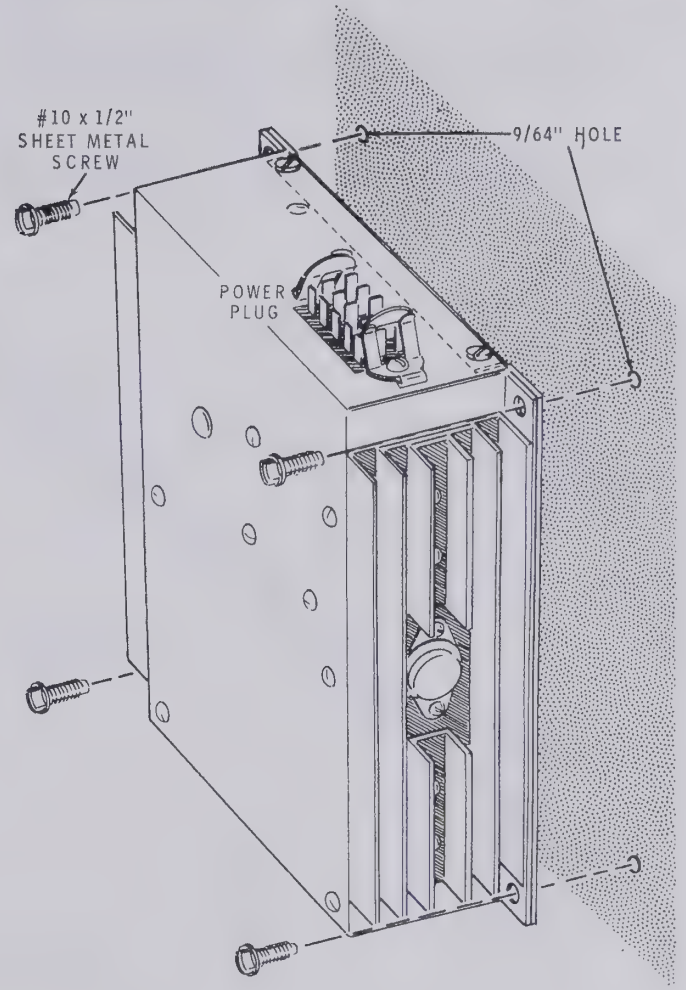


Figure 2

( ) Refer to Figure 2 and mount the Power Supply at the prepared location. Start four #10 x 1/2" sheet metal screws into the mounting surface; then tighten them securely.

( ) Attach the power cable connector to the connector on the chassis. Be sure the connectors are coupled firmly together.

BATTERY CONNECTIONS

NOTE: If the vehicle battery cables terminate in spring connectors, connect the 2-wire cable to the starter solenoid instead of the battery. Follow the directions for the specific conditions you encounter.

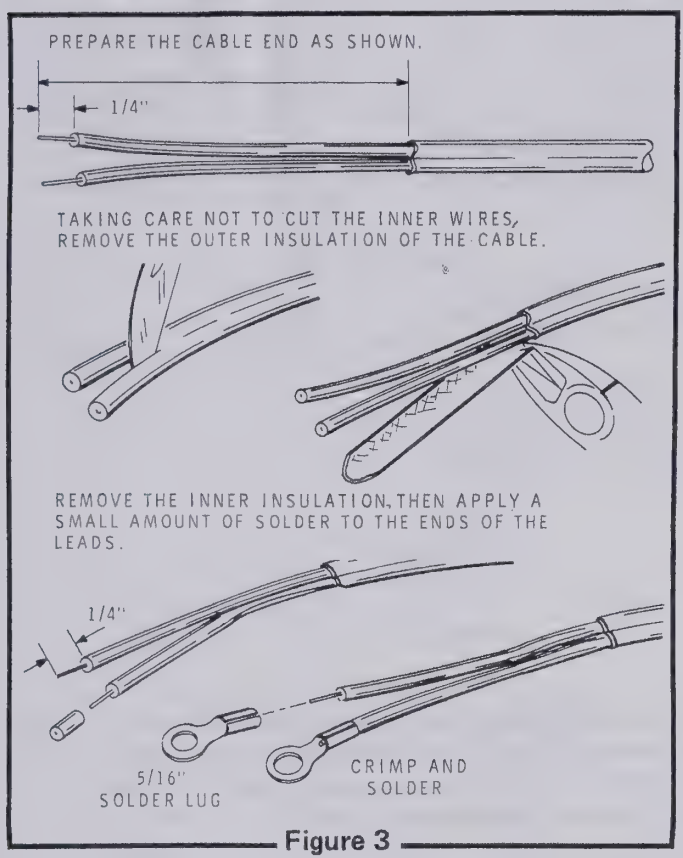


Figure 3

Connecting to Battery

( ) Route the 2-wire cable to the battery. Make sure the cable clears all moving parts and is not near the exhaust manifold. Allow sufficient cable length so the wires can be connected to the battery terminals. Then cut off the excess cable.

( ) Refer to Figure 3 and prepare the end of the 2-wire cable.

( ) Remove the nut from the negative (–) battery cable clamp. Slip the terminal of the brown wire over the bolt. Then replace and tighten the nut securely.

( ) In a similar manner, connect the red wire to the positive (+) battery terminal. Tighten the nut securely.

Connecting to Starter Solenoid

( ) Route the 2-wire cable to the starter solenoid. Make sure the cable clears all moving parts and is not near the exhaust manifold. Allow sufficient cable length so the brown wire will reach a good ground on the engine, and the red wire will reach the starter solenoid terminals. Then cut off the excess cable.

( ) Refer to Figure 3 and prepare the end of the 2-wire cable.

( ) Connect the brown wire to a good ground (engine block or starter mounting bolts).

( ) Connect the red wire to the battery terminal of the starter solenoid. This is the terminal to which the positive (+) battery cable is connected.

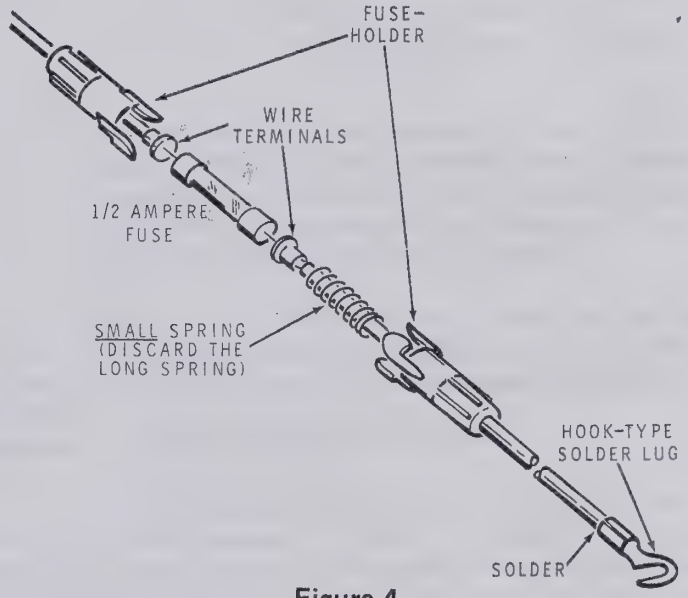


Figure 4

SWITCHING

The relay in the Power Supply is energized by applying 12 volts DC to the relay coil from an external source. All power to the equipment with which the Power Supply is used as well as the power to the Power Supply is controlled by the relay. In effect, the relay is an on-off switch for the entire system.

Some Heathkit Transceiver and Transmitter assembly manuals have specific information for power switching connections to the Power Supply. If you do not have specific directions on this point, use the following procedure.

There are basically two ways to obtain 12 volts DC to control the relay. The first, and preferable way, is from the ignition switch. The second way is directly from the battery. Either source may be used. An in-line fuseholder, a 1/2-ampere fuse, and a hook type solder lug are supplied for this purpose. Prepare the fuseholder as shown in Figure 4.

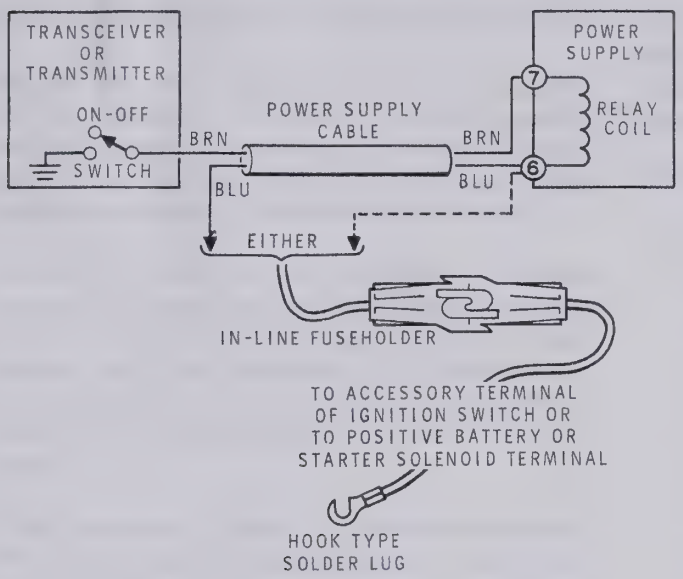


Figure 5

The switching hookup is shown in Figure 5. Connect one lead of the fuseholder to the 12-volt DC source; the other lead should be connected to either pin 6 of the 8-wire cable connector, or to the blue wire at the free end of the 8-wire cable.

The relay can be energized by grounding the other side of the relay coil. This is usually accomplished by a simple SPST switch in the transceiver or transmitter with which the Power Supply is used. The brown wire at the free end of the 8-wire cable should be connected to one terminal of the switch. The other switch terminal should be connected to ground. When the switch is closed, it completes the 12 volt DC circuit for the relay coil and energizes the relay. The relay then turns on the complete system.

COLOR	VOLTAGE
ORG	+LV*
RED	+12 VDC
WHT	GROUND
BLK	GROUND
GRN	–130 VDC
YEL	+800 VDC
BLU	RELAY
BRN	RELAY

*250 VDC LOW TAP
300 VDC HIGH TAP

Figure 6

Figure 6 shows the voltage present at each of the color-coded wires at the free end of the 8-wire cable. Connect these wires to your equipment accordingly.

OVERLOAD PROTECTION

If an overload or short circuit causes one or both of the circuit breakers to "open," the Power Supply must be turned off for approximately 30 seconds. This allows the load delay thermal switch within the circuit breaker to reset and close the circuit again.

IN CASE OF DIFFICULTY

This section of the Manual is divided into two parts. The first part, titled "General Troubleshooting Information," describes what to do about any difficulties that may occur right after the Power Supply is assembled.

The second part, "Resistance Checks," is provided to assist if the "General Information" does not clear up the problem, or if difficulties occur after the Power Supply has been in operation for some time.

GENERAL TROUBLESHOOTING INFORMATION

1. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the builder.

2. About 90% of the kits that are returned to Heath Company for repair do not function properly due to poor connections and soldering. Therefore, many troubles can be eliminated by reheating all connections to make sure that they are soldered as described in the soldering section of the "Kit Builders Guide."

3. Check the values of the parts. Be sure that the proper part has been wired into the circuit, as shown in the Pictorial diagrams and as called out in the wiring instructions.

4. Check for bits of solder, wire ends, or other foreign matter which may be lodged in the wiring.

5. If, after careful checks the trouble is still not located, check voltaged readings against those on the Schematic. NOTE: All voltage readings were taken with an 11 megohm input voltmeter. Voltages shown are with no load on the output.

6. A review of the "Circuit Description," and a study of the Schematic Diagram will help you locate a difficulty in the Power Supply.

7. Check for loose hardware.

NOTE: In an extreme case where you are unable to resolve a difficulty, refer to the "Customer Service" information inside the rear cover of the Manual. Your Warranty is located inside the front cover of the Manual.

RESISTANCE CHECKS

1. Resistance from terminal 1 of the power transformer to chassis ground should be 50-100 Ω. NOTE: This should be measured with an ohmmeter on the RX1 scale. If the reading is below 30 ohms, either Q1, or Q2, or both are shorted. Reversed meter leads should give a reading of approximately 2 Ω.

2. Make forward and reverse resistance checks on diodes D1 through D7. This can be done by using an ohmmeter on the RX1 scale. In one direction the resistance will be 10 Ω; reversing the leads should give a reading of infinity. If the readings vary greatly from the values given, it would indicate that the diode is either open or shorted.

3. Check the circuit breakers for continuity. Also make sure the fiber shoulder washers are properly seated in the circuit breaker bracket.

4. Disconnect one lead of filter choke L1. The resistance of the choke is approximately .6 Ω.

5. Use the ohmmeter to check for continuity between the various transformer windings. NOTE: The transformer leads must be disconnected for this check.

Since the relay is on the on-off switch for the complete system, check its operation. Also check the circuit breakers. Repeated opening of a circuit breaker indicates an overload or short in the circuit supplied through the circuit breaker.

SPECIFICATIONS

Input Voltage	12 to 16 volts DC (negative ground).
Input Current	25 amperes maximum with full load.
Allowable Ambient Temperature	—10 degrees Fahrenheit to 122 degrees Fahrenheit.
High Voltage Output	800 volts DC with no load. 750 volts DC with 250 mA load.
Effective Output Capacitance	10 μF.
Ripple	Less than 1% at 250 mA.
Duty Cycle	Continuous up to 150 mA. 50% up to 300 mA. SSB duty up to 300 mA.
Low Voltage Output (High Tap) 300 volts DC with 150 mA load.	310 volts DC with no load.
Ripple	Less than .05% at 150 mA.
Duty Cycle	Continuous up to 175 mA.
Low Voltage Output (Low Tap)	265 volts DC with no load. 250 volts DC with 150 mA load.
Ripple	Less than .05% at 150 mA.
Duty Cycle	Continuous up to 175 mA.
Bias Voltage	—130 volts DC with 20 mA load.
Duty Cycle	Continuous up to 20 mA.
Switching Frequency	1500 Hz (approximate).
Cabinet Dimensions	7-3/4" wide x 7-5/16" long x 2-3/8" deep.
Net Weight	5-1/4 lbs.

NOTE: A 13.6 volt DC input was used in determining electrical specifications.

The Heath Company reserves the right to discontinue instruments and to change specifications at any time without incurring any obligation to incorporate new features in instruments previously sold.

CIRCUIT DESCRIPTION

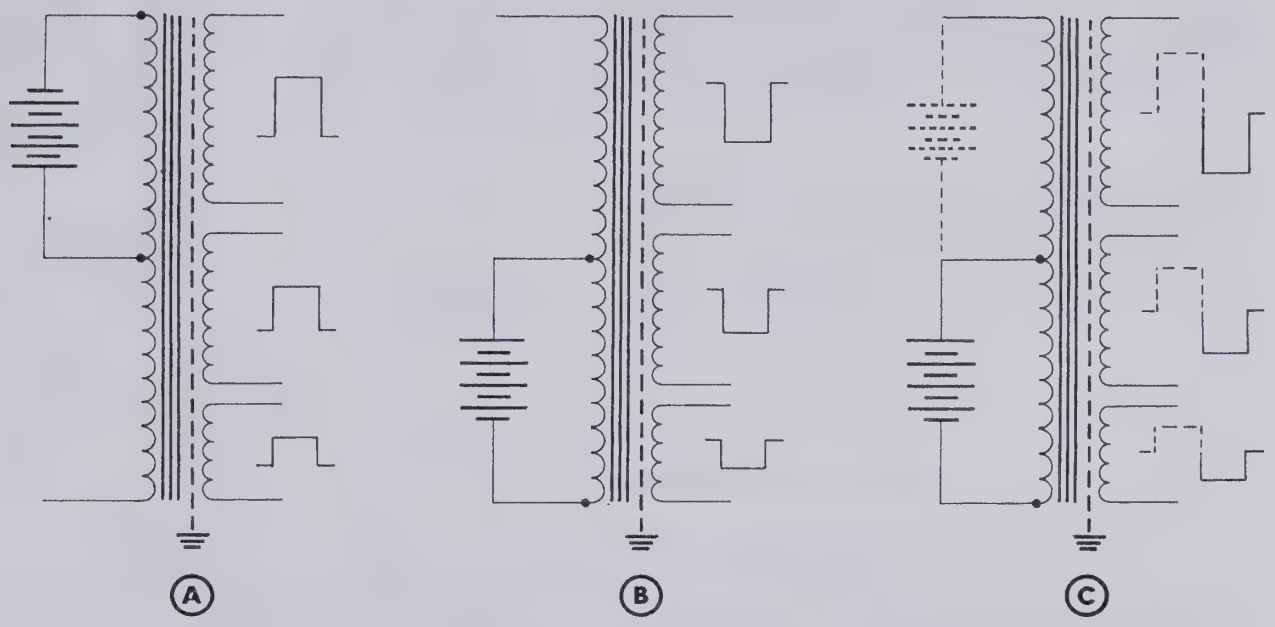


Figure 7

While you read the following "Circuit Description," refer to the Power Supply Schematic and Block Diagrams and to the Figures in the text to obtain a thorough understanding of the circuit operation.

PRIMARY CIRCUIT

The battery voltage available at the 15-terminal input-output connector of the Power Supply is applied through a 40 ampere circuit breaker to the relay contacts. When the relay is energized by external switching of 12 volts DC to the relay coil, this DC voltage is connected through the relay and through a 10-ampere circuit breaker to the filament voltage terminal of the connector. Battery voltage is also applied through suppression choke L2 to the center of the transformer primary winding.

To produce the high DC voltages required to operate mobile electronic equipment, a suitable converter must be used to change battery voltage (DC) to alternating current (AC) for the necessary transformer voltage step-up action. In the Transistorized Power Supply, this conversion is accomplished with two heavy duty transistors which act as switches, and a very efficient toroid power transformer.

The switching action of the transistors is similar to that of a vibrator which uses a contact-carrying, vibrating reed to energize first one half and then the other half of the transformer primary winding. However, a vibrator is an electromechanical switch whose contacts may, after use, become burned and pitted and require replacement of the vibrator.

The two transistors also alternately connect battery voltage across first one half and then the other half of the transformer primary winding. As there are no moving parts involved in this system, mechanical wear is eliminated. Transistors have extremely long life characteristics and require a minimum of maintenance. Transistor switching action is shown in Figures 7A, 7B, and 7C.

The basic converter circuit is shown in Figure 8, which indicates the relative phase and amplitude of the primary and secondary voltages. When power is first applied to the primary circuit, an imbalance will exist between the two transistor circuits due primarily to slight differences in transistor and transformer winding characteristics. This imbalance causes one transistor to momentarily conduct and apply battery voltage across one section of the transformer primary winding, either section A1 or A2 depending upon which transistor is in initial control.

The polarity of the base feedback voltage, with respect to the transformer primary, is such that it drives the "initial control" transistor into very heavy conduction; collector current is several amperes, depending upon the load on the Power Supply output. Degeneration causes the other transistor to be cut off completely.

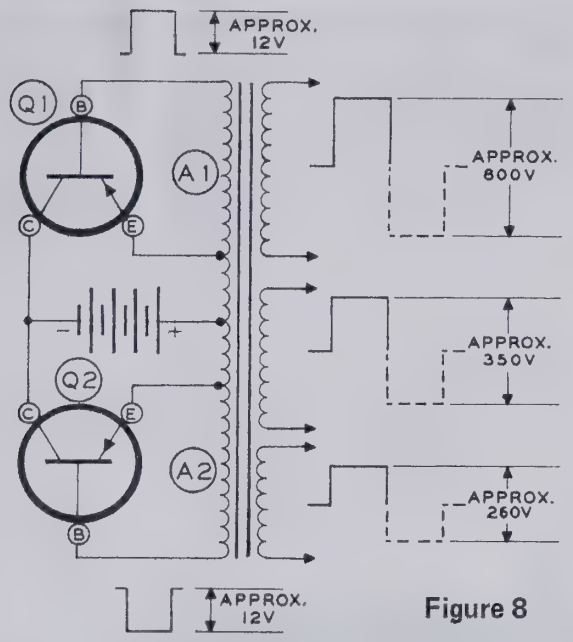


Figure 8

This condition of high current flow will continue until the transformer core reaches saturation. When core saturation occurs, the rate of change of flux approaches zero. The circuit is then unable to maintain the large driving current in the base circuit of the conducting transistor, resulting in a decrease of collector current. This decrease in collector current causes a further decrease of base drive. Circuit feedback is such that continued reduction of base drive causes the conducting transistor to stop conducting (switch off), and the other transistor to begin conducting (switch on).

As the primary circuitry is symmetrical, the operation of the second transistor is identical to that of the initial control transistor. The conditions are duplicated, causing resaturation of the transformer core. This rapid change in core saturation induces a square wave alternating voltage in the transformer secondary windings, in proportion to the turns ratio between the primary and secondary. The cycle will continue to repeat itself and produce the necessary high voltage AC in the transformer secondary windings.

The transistors operate at a nominal switching frequency of 1500 Hz. This frequency represents a good compromise of efficiency, filtering, and operating temperatures. At higher frequencies, the time required for the transistors to switch on and off is a large portion of the operating cycle; this results in low efficiency. At lower frequencies, larger value filter capacitors would be required and a much larger transformer would be needed. The switching frequency is determined by a number of factors, including transistor circuit values, and transformer and transistor characteristics.

The transformer used in this Power Supply is a very efficient toroid type, designed to operate at a frequency of approximately 1500 Hz. The transformer will run relatively warm even under no load. This condition is normal for a transformer operated near or in a saturated condition.

Transistors used in this type of switching application operate at high current during one-half of each cycle. The transistor heat which occurs is effectively dissipated by radiation from the heat sink assemblies, which are cooled by air circulating around the heat sink fins.

SECONDARY CIRCUIT

High Voltage Section

The high voltage DC section uses a full-wave voltage-doubler circuit, consisting of diodes D1, D2, D3, and D4 with capacitors C3 and C4. A voltage-doubler circuit produces a DC output of approximately twice the peak value of the alternating voltage available at the secondary winding of the transformer. Diodes D1 and D2 rectify one-half cycle of voltage, and D3 and D4 rectify the other half cycle. On alternate half cycles, capacitors C3 and C4 charge to the approximate value of the AC voltage appearing across the transformer secondary winding. The polarity is such that the DC voltages developed across these two capacitors add together; this "doubled" DC voltage appears between ground and the junction of D4, C3, and R3. Capacitors C3 and C4 with resistors R3 and R4 provide filtering. R3 and R4 also act as bleeder resistors to provide a discharge path for the voltage doubler capacitors when the power supply is turned off.

Buffer capacitor C2 absorbs transient voltage surges that occur in the secondary winding as a result of transistor switching action in the primary circuit.

Low Voltage Section

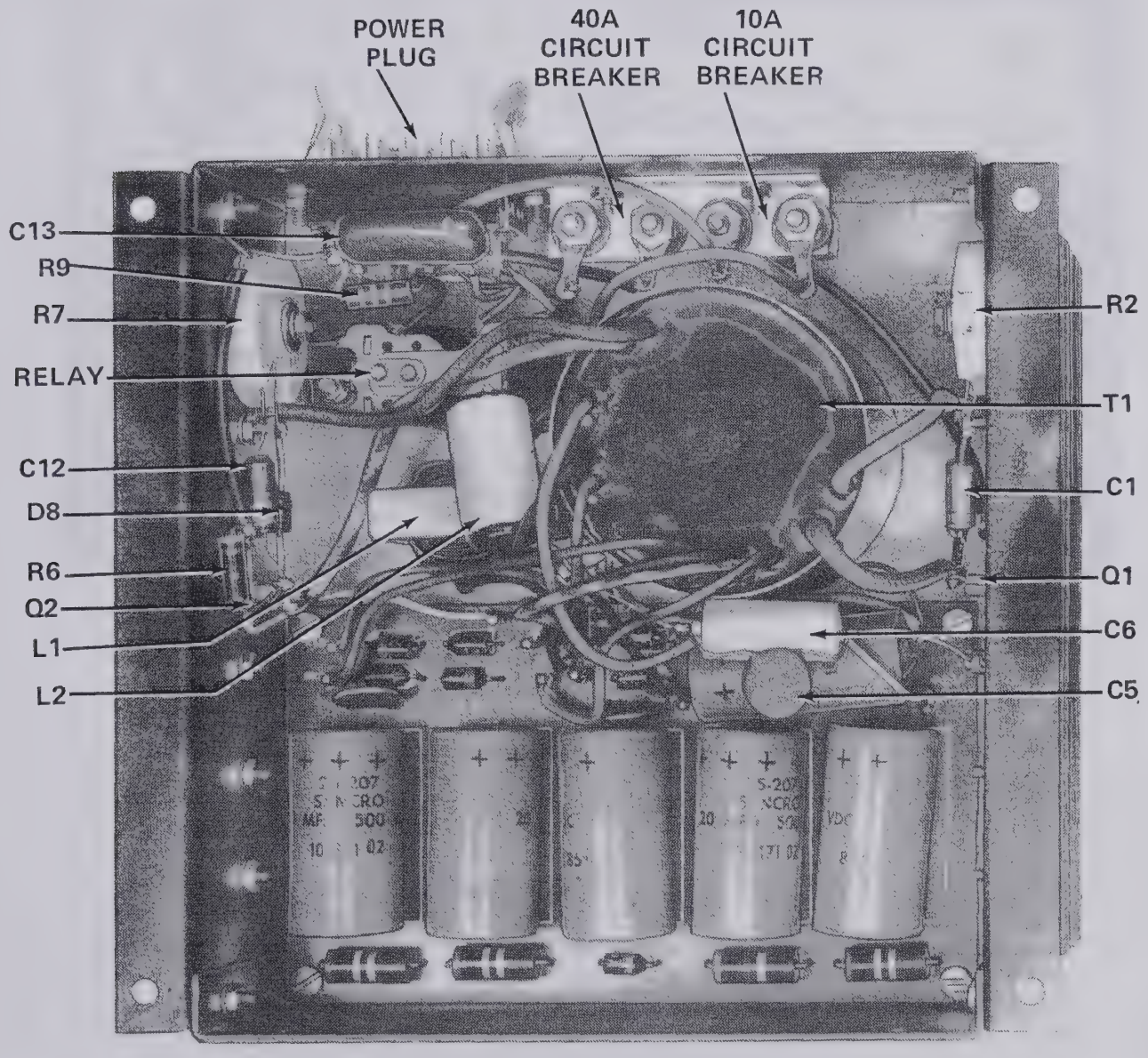
The low voltage DC section also uses a fullwave voltage-doubler circuit, made up of diodes D5 and D6 with capacitors C8 and C10. Capacitors C8, C9, and C10 with choke L1 filter the DC output voltage, which is then applied to the Power Supply connector. R5 is a bleeder resistor, and C7 is a buffer capacitor.

The low voltage secondary winding is tapped to provide a choice of two different output voltages. Either the blue-green or the blue-yellow transformer lead may be connected to the voltage-doubler circuit. The blue-green lead provides the higher output voltage. The choice of output voltages depends on the requirements of the equipment with which the Power Supply is used.

Bias Section

The bias voltage section uses diode D7 as a half-wave rectifier. The filter network consists of capacitors C11A and C11B with resistor R8. Resistor R9 is a bleeder resistor.

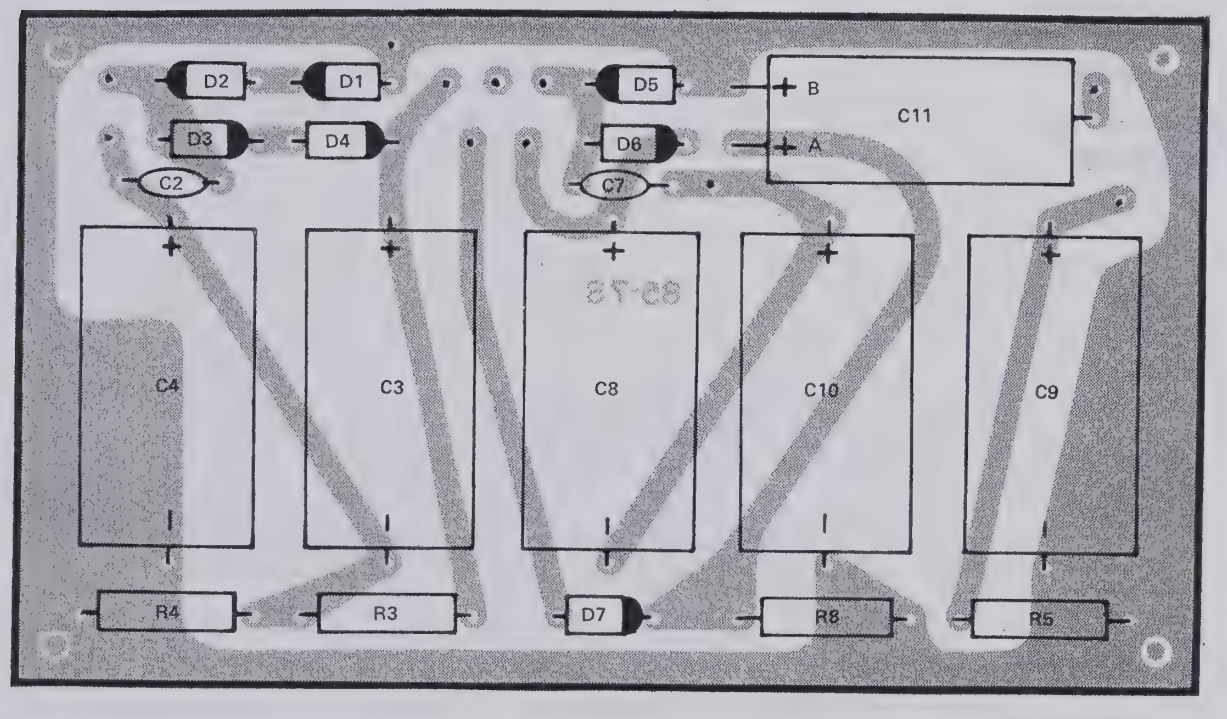
CHASSIS PHOTOGRAPH



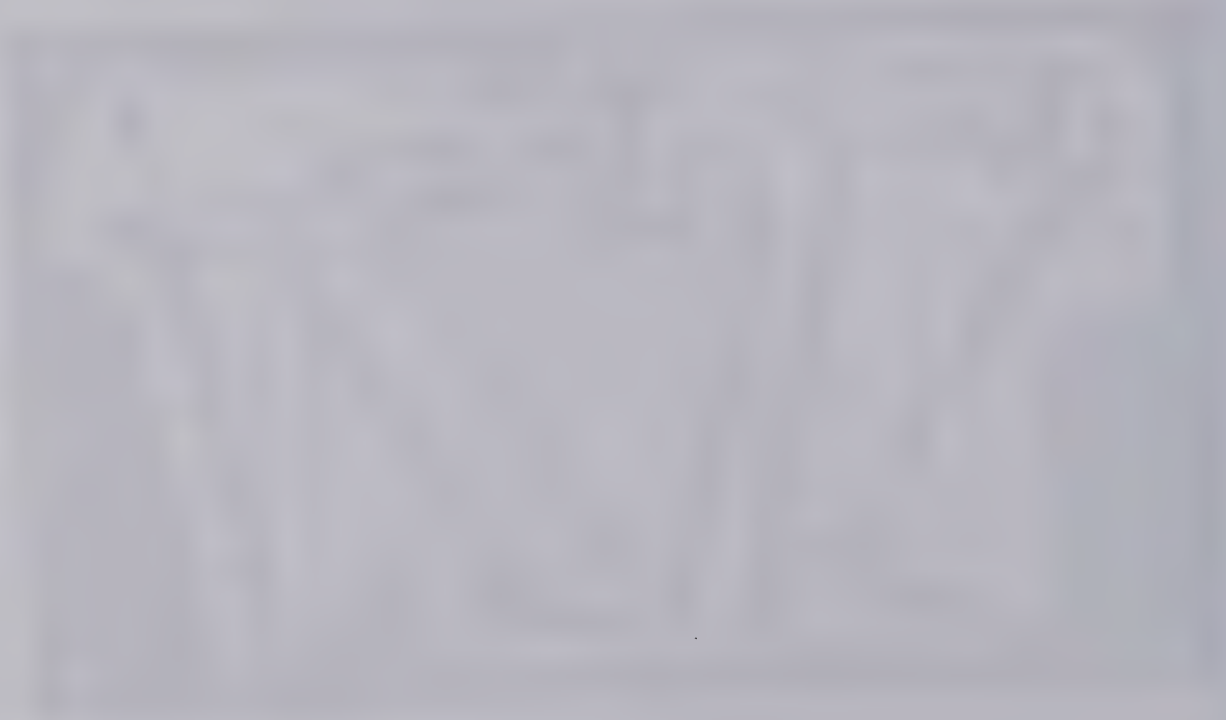
X-RAY VIEW

NOTE: To identify a part shown in one of these Views, so you can order a replacement, proceed as follows:

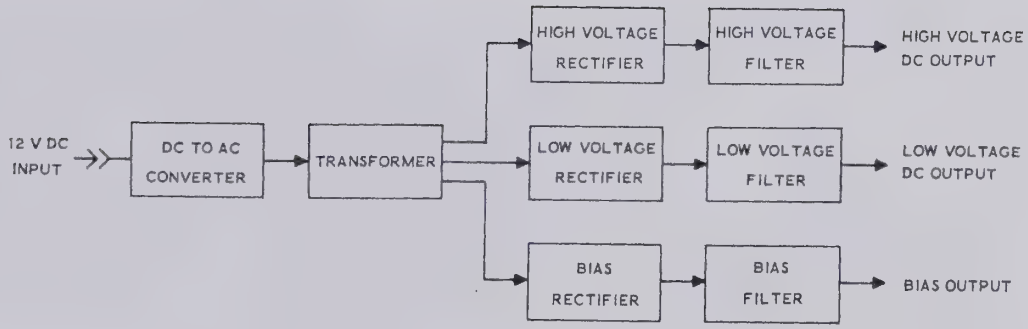
1. Note the identification number of the part (R-number, C-number, etc.).
2. Locate the same identification number (next to the part) on the Schematic. The "Description" of the part (for example: 22 kΩ, .05 μF, or 2N2712) will also appear near the part.
3. Look up this Description in the Parts List.



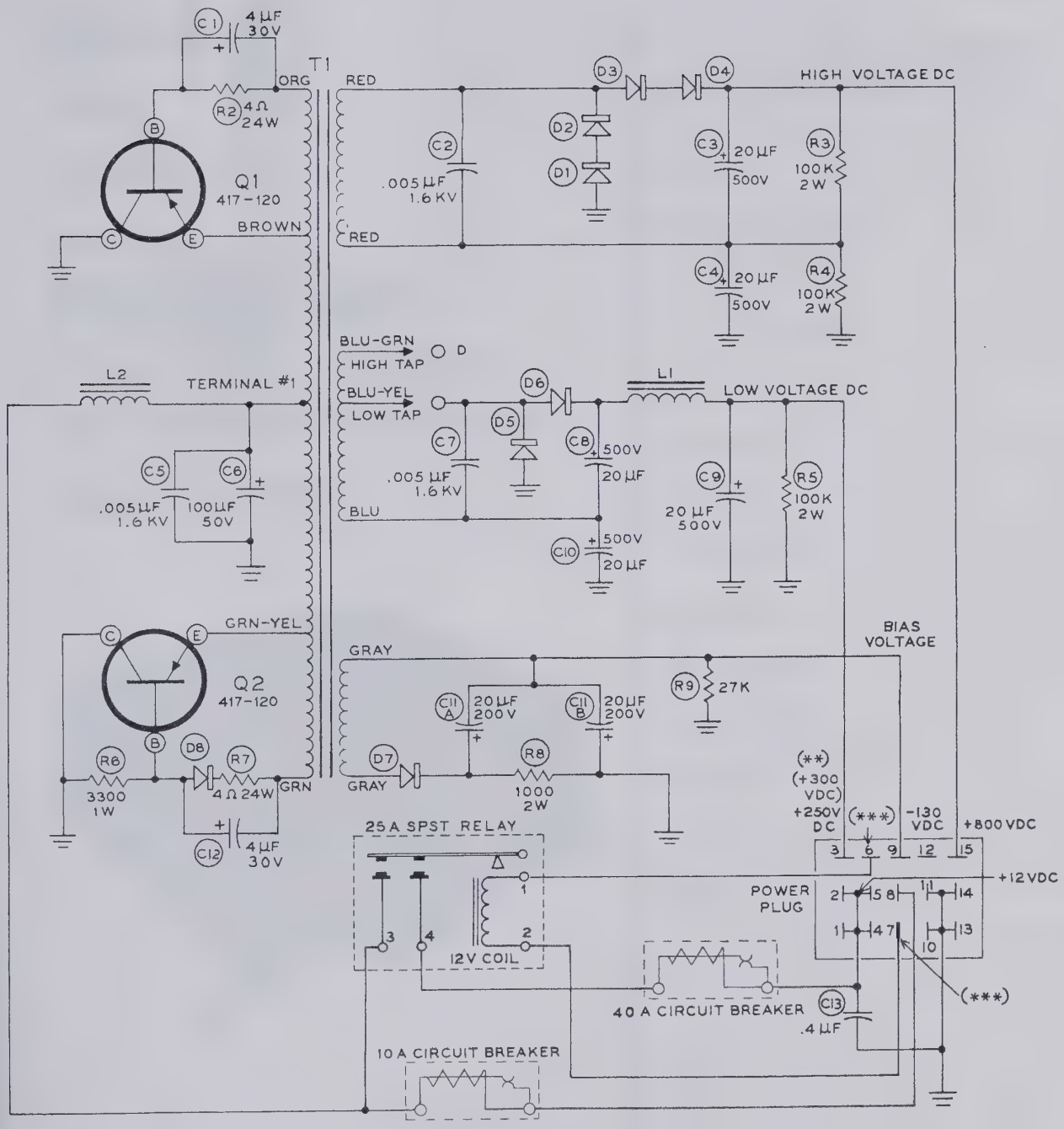
(Shown from component side)



SCHEMATIC OF THE
HEATHKIT®
TRANSISTORIZED
DC POWER SUPPLY
MODEL HP-13B



BLOCK DIAGRAM



SISTANCES IN OHMS (K=1000, M=1,000,000).

LTAGES MEASURED FROM INDICATED POINT TO CHASSIS D.

PLUG TERMINALS VIEWED FROM INSIDE OF CHASSIS.
R LETTER-NUMBER DESIGNATIONS SHOWN ON CHASSIS GRAPHS AND CIRCUIT BOARD X-RAY VIEW.

(* *) +250 V DC LOW TAP.
+300 V DC HIGH TAP.

(***) LUG #6 AND/OR LUG #7 MAY HAVE 12 VDC WITH RESPECT TO GROUND, DEPENDING UPON THE SPECIFIC CIRCUITRY AND CONNECTIONS OF THE EQUIPMENT USED WITH THE POWER SUPPLY.

CONDENSED

Assembly and Operation of the HEATHKIT™ TRANSISTORIZED DC POWER SUPPLY

MODEL HP-13B

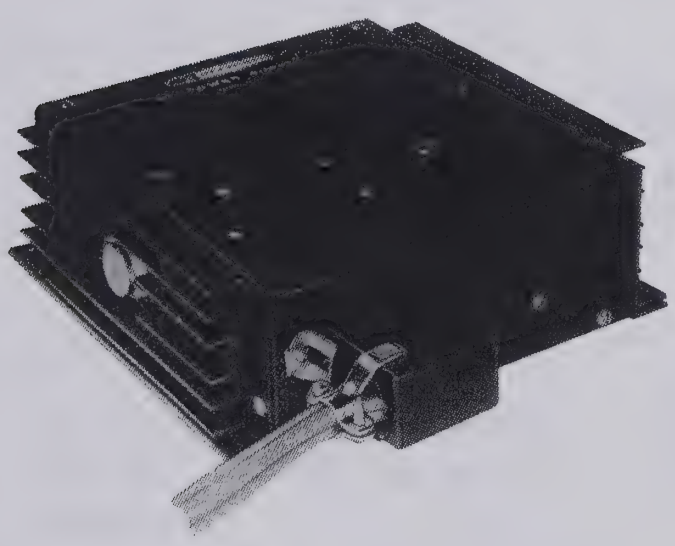


TABLE OF CONTENTS

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

INTRODUCTION

The Heathkit Model HP-13B Transistorized DC Power Supply was designed to furnish all necessary operating power for Heathkit Mobile Amateur Transmitters, Transceivers, and Receivers, as well as for other brands of mobile equipment.

This Power Supply is actually three DC power sources in one unit. It provides high voltage (750 volts), low voltage (300 or 250 volts), and bias voltage (—130 volts). It also switches DC filament voltage for the equipment with which it is used.

Circuit features include relay control of all primary power, plus individual circuit breaker protection of the DC input to the Power Supply and of the DC filament voltage line to the equipment used with the Power Supply. The circuit breakers are the automatic reset, load delay type. They insure positive protection for all equipment involved in case of an overload or accidental short circuit.

The power transformer, an epoxy encapsulated toroid unit is of advanced design, assuring maximum efficiency. This transformer, in conjunction with the power transistors used as a DC-to-AC converter, provides a high frequency switching rate along with high power and instant starting. Specially designed heat sink assemblies provide maximum transistor cooling.

Efficient, long life silicon rectifiers and heavy-duty filter capacitors, mounted on a rugged circuit board, provide trouble-free rectification and filtering.

Because the complete Power Supply is physically small, it requires a minimum of mounting space. Under-the-hood mounting is recommended.

Read the "Kit Builders Guide" for complete information on unpacking, parts identification, tools, wiring, soldering, and step-by-step assembly procedures.

PARTS LIST

Check each part against the following list. The key numbers correspond to numbers on the Parts Pictorial (fold-out from Page 3).

To order replacement parts use the Parts Order Form furnished with this kit. If a Parts Order Form is not available, refer to the "Parts Replacement" inside the rear cover of the Manual.

Any part that is packaged in an individual envelope with a part number on it should be placed back in its envelope after it is identified, until that part is called for in a step.

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
RESISTORS				
A1	1-3-1	1	3300 Ω (orange-orange-red), 1-watt	.10
A1	1-46-1	1	27 kΩ (red-violet-orange), 1-watt	.10
A2	1-15-2	1	1000 Ω (brown-black-red), 2-watt	.15
A2	1-24-2	3	100 kΩ (brown-black-yellow), 2-watt	.15
A3	3-1-24	2	4 Ω, 24-watt, ceramic	.95
CAPACITORS				
B1	21-35	3	.005 μF 1.6 kV disc	.15
B2	25-254	2	4 μF electrolytic	.50
B3	25-206	1	20-20 μF electrolytic	.85
B4	25-207	5	20 μF electrolytic	.85
B4	25-28	1	100 μF electrolytic	.60
B5	27-20	1	.4 μF Mylar*	.30

*DuPont Registered Trademark

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
CIRCUIT BREAKERS-RELAY-CHOKES-TRANSFORMER				
C1	65-20	1	10-ampere circuit breaker	.80
C1	65-16	1	40-ampere circuit breaker	.80
C2	69-68	1	12-volt relay	5.00
C3	45-59	1	Suppression choke	.60
C4	46-24	1	Filter choke	1.30
C5	54-144	1	Power transformer	27.95
DIODES-TRANSISTORS				
D1	57-27	7	Silicon diode, 600V, 1A (1N2071)	.50
D1	57-42	1	Silicon diode, 100V, 3A (3A1)	1.15
D2	417-120	2	Power transistor	5.00
FUSEHOLDER-PLUG-CABLE CONNECTOR				
E1	423-10	1	In-line fuseholder	.50
E2	432-34	1	15-contact plug	1.20
E3	432-35	1	15-contact connector	2.10
METAL PARTS				
F1	200-633-1	1	Chassis	2.50
F2	204-549	1	Circuit breaker mounting bracket	.15
F3	205-417-1	1	Bottom plate	.85
F4	215-11-1	2	Heat sink (bottom section)	.60
F5	215-12-1	2	Heat sink (middle section)	.25
F6	215-13-1	4	Heat sink (top section)	.15
HARDWARE				
#6 Hardware				
G1	250-235	8	6-32 x 1/4" screw	.05
G2	250-233	12	6-32 x 3/8" screw	.05
G3	250-234	10	6-32 x 1/2" screw	.05
G4	250-364	2	6-32 x 7/8" screw	.05
G5	250-237	4	#6 x 3/8" sheet metal screw	.05
G6	252-77	24	6-32 nut	.05
G7	253-96	2	#6 flat washer	.05
G8	254-25	26	#6 lockwasher	.05
G9	259-1	4	#6 solder lug	.05
G10	255-23	4	#6 threaded spacer	.05
#10 Hardware				
G11	250-83	4	#10 x 1/2" sheet metal screw	.05
G12	252-63	8	10-32 nut	.05
G13	253-3	4	#10 fiber flat washer	.05
G14	253-7	4	#10 fiber shoulder washer	.05
G15	254-36	1	#10 lockwasher	.10
G16	259-5	4	#10 solder lug	.05
MISCELLANEOUS				
	85-78-2	1	Circuit board	1.80
H1	259-15	1	Hook type solder lug	.05
H2	259-20	2	Circuit board solder terminal	.05
H3	262-8	9	Circuit board solder pin	.05
H4	259-21	2	5/16" solder lug	.05
H5	260-32	2	Cable connector clip lock	.30
	344-2	1	Black wire	.05/ft
	346-2	1	Large sleeving	.05/ft
	347-13	1	2-wire cable	.15/ft
	347-52	1	8-wire cable	.60/ft
	421-13	1	1/2-ampere fuse	.15
	490-5	1	Nut starter	.10
	391-34	1	Blue and white identification label	
	597-260	1	Parts Order Form	
	597-308	1	Kit Builders Guide	
		1	Manual (See front cover for part number.)	2.00
			Solder (Additional 3' rolls of solder, #331-6, can be ordered for 15 cents each.)	

The above prices apply only on purchases from the Heath Company where shipment is to a U.S.A. destination. Add 10% (minimum 25 cents) to the price when ordering from a Heathkit Electronic Center to cover local sales tax, postage, and handling. Outside the U.S.A. parts and service are available from your local Heathkit source and will reflect additional transportation, taxes, duties, and rates of exchange.

( ) Blue lead to the circuit board pin marked BLUE (S-1).

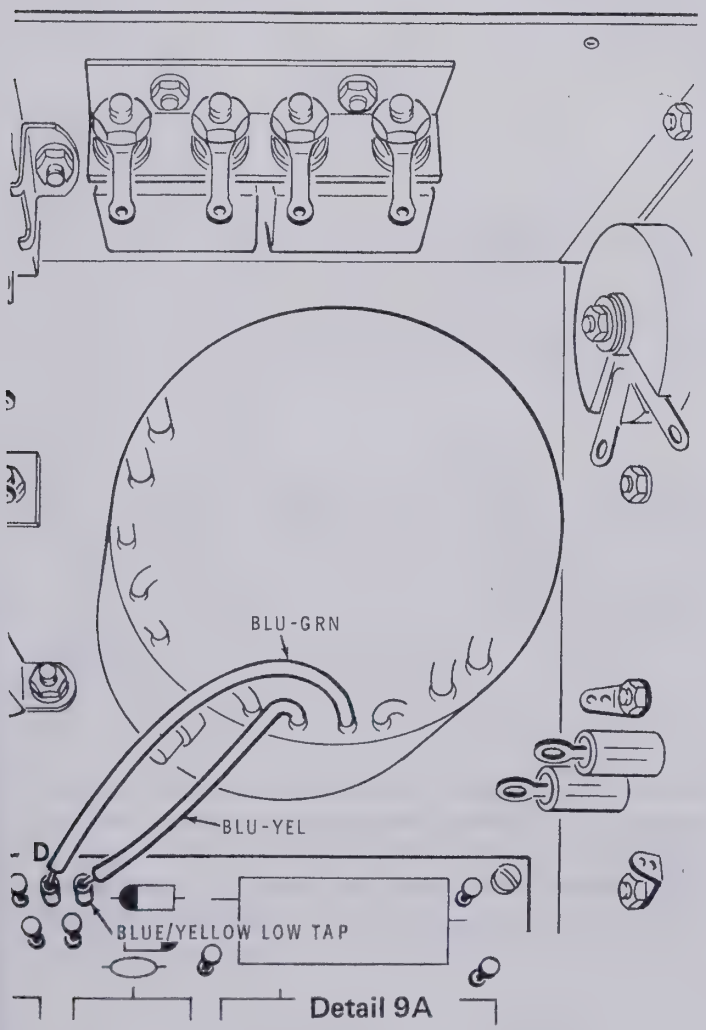
( ) 6" gray lead to the circuit board pin marked BIAS (S-2).

( ) Green-yellow lead to lug 2 of transistor AE (S-1).

( ) Green lead to lug 1 of resistor AH (S-2). Wrap this lead around the resistor lug.

( ) Carefully inspect the lugs of the resistors at CB and AH. Make sure the lugs do not touch the screws at CC and AG respectively.

IMPORTANT: The low voltage output circuit has two voltage values available. The low tap output is 250 volts DC. The high tap output is 300 volts DC. Determine which of these voltages is required for the equipment with which you plan to use the Power Supply. Then proceed to the steps for the voltage value you have selected. Terminal D on the circuit board is a "dummy" terminal. (Make sure the leads are soldered to the terminals and that the terminals are soldered to the circuit board.)



Detail 9A

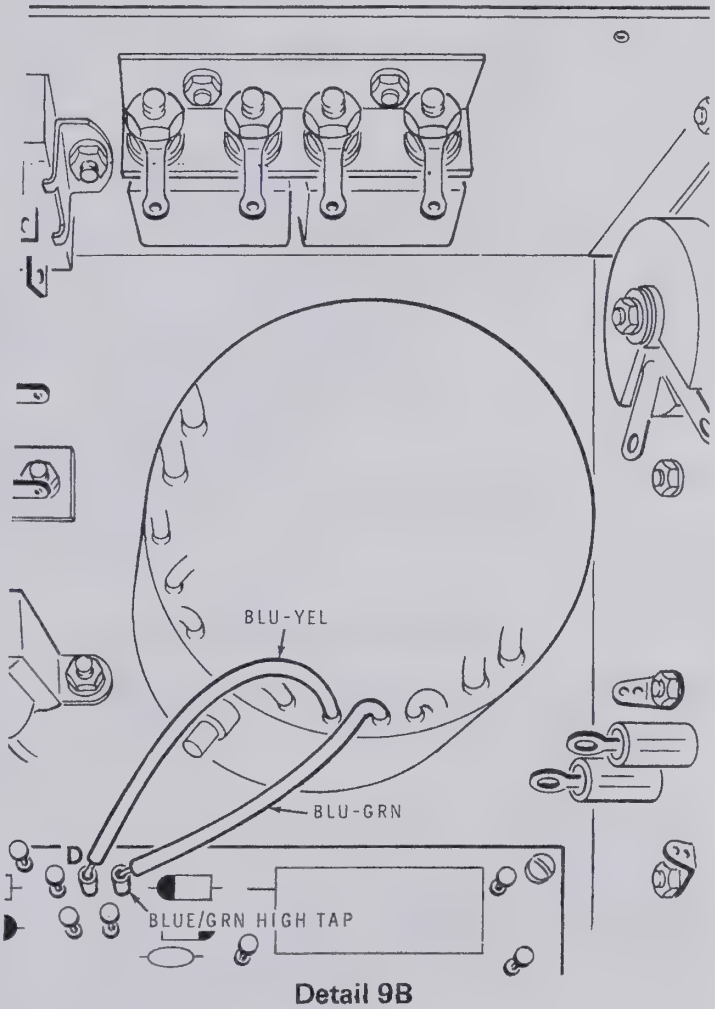
For 250-Volt DC Output

Refer to Detail 9A for the following steps.

( ) Blue-yellow lead to the solder terminal marked BLUE/YELLOW LOW TAP (S-1).

( ) Blue-green lead to the solder terminal marked D (S-1).

Proceed to "Cable Preparation."



Detail 9B

For 300-Volt DC Output

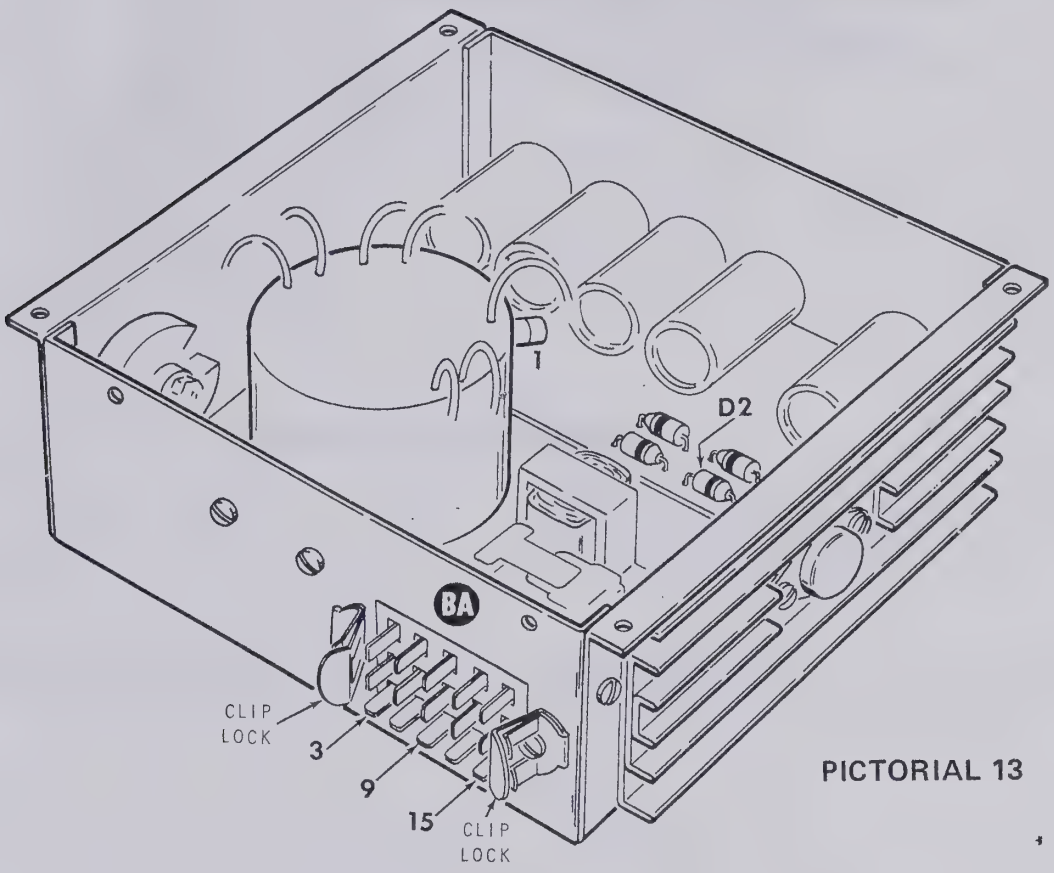
Refer to Detail 9B for the following steps.

( ) Blue-green lead to the solder terminal marked BLUE/GRN HIGH TAP (S-1).

( ) Blue-yellow lead to the solder terminal marked D (S-1).

Proceed to "Cable Preparation."

INITIAL TESTS



PICTORIAL 13

To avoid possible damage, it is important that you use an ohmmeter to make the following resistance checks before you connect or turn on the Power Supply. If you cannot obtain the proper ohmmeter indication in the following steps, refer to the "In Case of Difficulty" section. DO NOT turn on the Power Supply until the difficulty has been corrected.

NOTE: Use a vaccum tube voltmeter (VTVM) or a volt-ohmmeter (VOM) to make the resistance check in the following steps (solid-state ohmmeters do not furnish a voltage high enough to make the diodes conduct in the circuit being tested). Make sure you have the ohmmeter set correctly, since the range setting influences the meter reading when a diode is in the circuit.

( ) Set the ohmmeter to the RX1 range.

Because some of the circuits to be measured contain diodes, you will obtain different resistance readings if the polarity of the meter leads is reversed in the following measurements. Therefore, in the next two steps you will determine the polarity of the ohmmeter test leads and connect the proper lead to chassis ground.

Refer to Pictorial 13 for the following steps.

( ) Make sure the clip locks do not touch any lugs of connector BA. If necessary, bend the clip locks back slightly.

( ) Connect the negative meter lead to the banded end of diode D2. Connect the positive meter lead to the other diode lead. If the resistance is approximately 10 ohms, connect the negative meter lead to the chassis (ground) for the following resistance checks and disregard the next step.

( ) If the meter needle remains on or near the infinity mark (full scale), reverse the meter leads. If you now obtain a reading of approximately 10 ohms, connect the positive meter lead to the chassis (ground) for the following resistance checks.

Make the resistance checks in the following chart from chassis ground to the indicated points. Some of the readings will take a few seconds to reach the specified resistance because of the slow charging rate of the capacitor in the Power Supply.

DO THIS:	THE RESISTANCE SHOULD BE:
( ) Measure terminal 1 on the transformer.	25 Ω or greater.
( ) Set the ohmmeter to the RX10k range.	
( ) Measure pin 3 of connector BA.	100 kΩ or greater.
( ) Measure pin 15 of connector BA.	200 kΩ or greater.
( ) Reverse the ohmmeter leads.	
( ) Measure pin 9 of connector BA.	25 kΩ or greater.
( ) Disconnect the ohmmeter leads.	

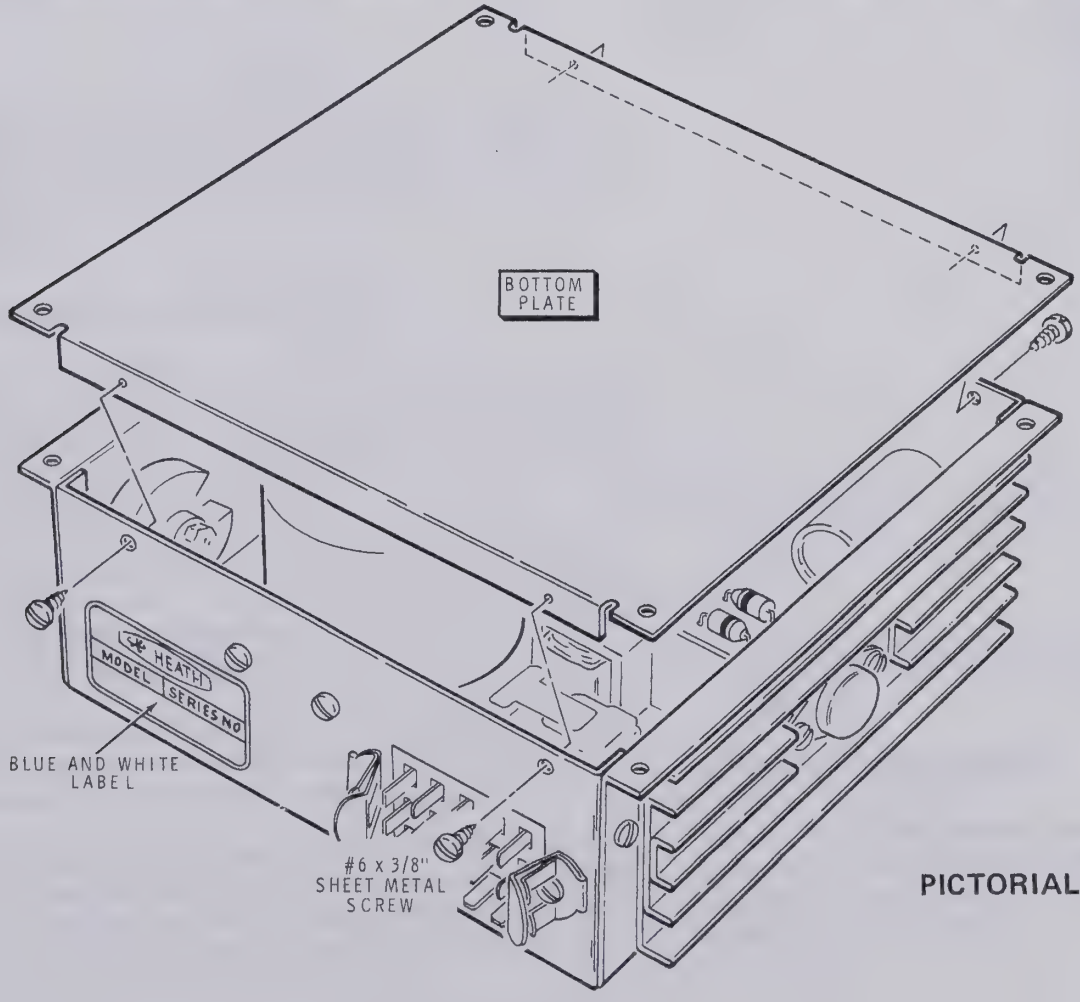
FINAL ASSEMBLY

Refer to Pictorial 14 for the following steps.

( ) Install the bottom plate on the chassis. Use four #6 x 3/8" sheet metal screws.

( ) Carefully peel away the paper backing from the blue and white identification label. Then press the label on the chassis at the location shown. Be sure to refer to the numbers on this label in any communications you have with the Heath Company about this kit.

This completes "Final Assembly." Proceed to "Installation."



PICTORIAL 14

INSTALLATION

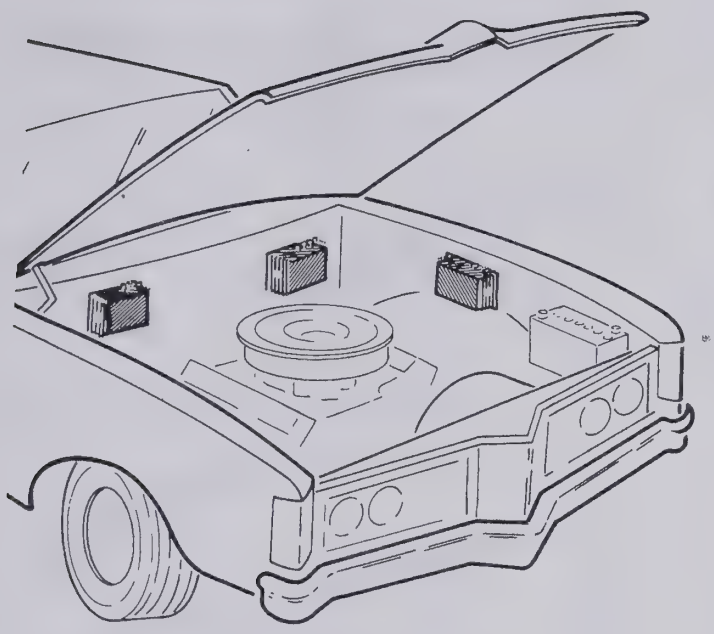


Figure 1

WARNING: Before you install this Power Supply in a vehicle, measure the generator or alternator output voltage. The voltage output of the charging system MUST NOT EXCEED 16 VOLTS.

MOUNTING CONSIDERATIONS

It is recommended that you mount the Power Supply under the hood. Figure 1 shows several possible under-the-hood mounting locations. Choose the location that is best for your particular installation and allows adequate ventilation and protection from water spray.

Mount the Power Supply as near to the vehicle battery or starter solenoid as practical. This will allow the 2-wire battery cable to be connected to either of these two points by the shortest route possible.

It is preferable that you mount the Power Supply with the heat sink fins vertical to provide maximum cooling of the transistor. However, this is not mandatory.

( ) When you have decided upon the mounting position, use the Power Supply as a template and mark the four hole locations on the chassis. See Figure 2. Drill a 9/64" hole at each of these four points.

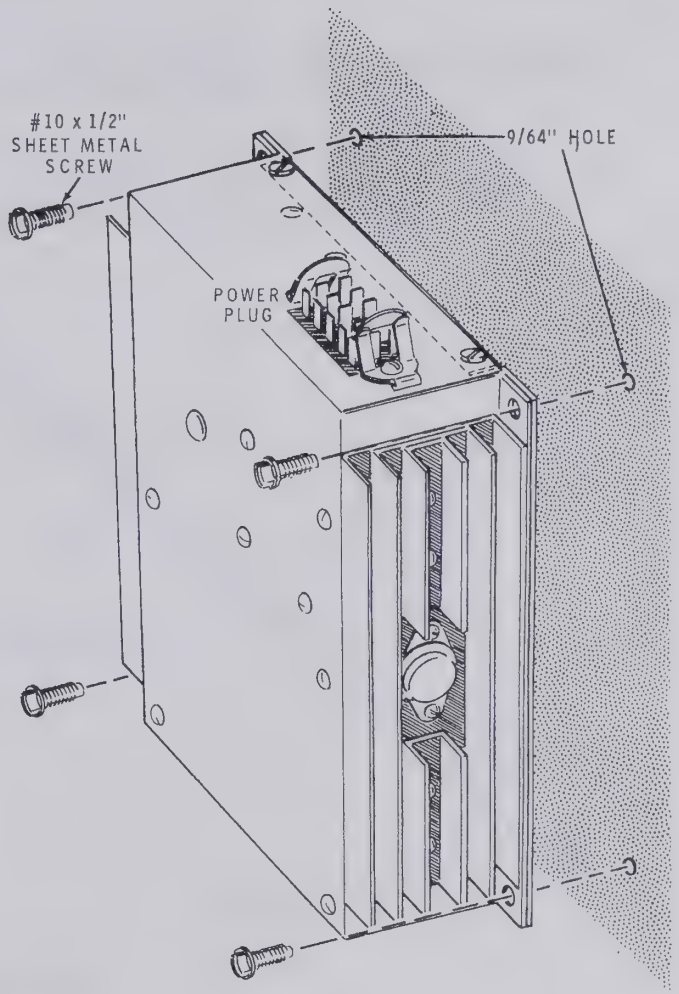


Figure 2

( ) Refer to Figure 2 and mount the Power Supply at the prepared location. Start four #10 x 1/2" sheet metal screws into the mounting surface; then tighten them securely.

( ) Attach the power cable connector to the connector on the chassis. Be sure the connectors are coupled firmly together.

BATTERY CONNECTIONS

NOTE: If the vehicle battery cables terminate in spring connectors, connect the 2-wire cable to the starter solenoid instead of the battery. Follow the directions for the specific conditions you encounter.

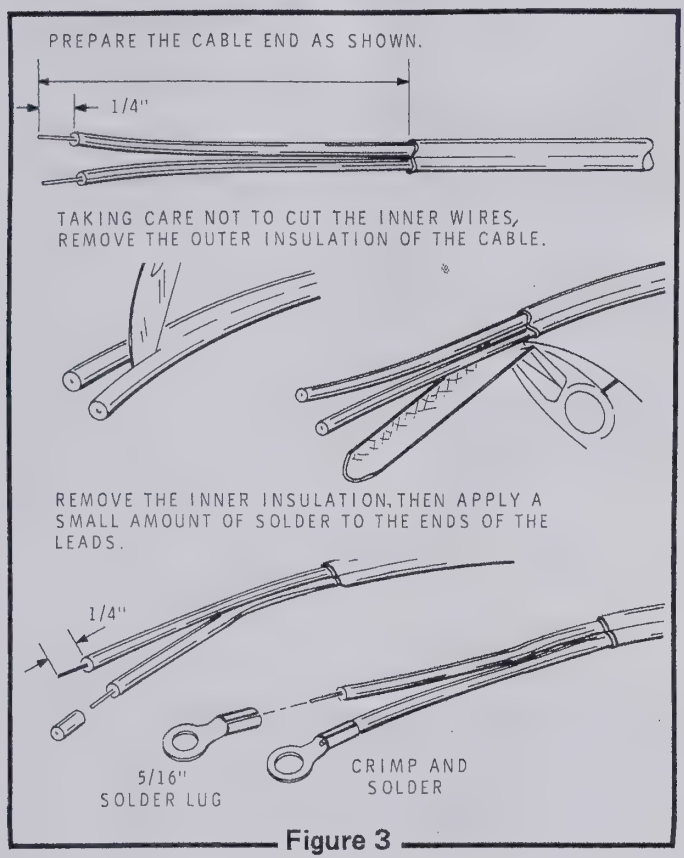


Figure 3

Connecting to Battery

( ) Route the 2-wire cable to the battery. Make sure the cable clears all moving parts and is not near the exhaust manifold. Allow sufficient cable length so the wires can be connected to the battery terminals. Then cut off the excess cable.

( ) Refer to Figure 3 and prepare the end of the 2-wire cable.

( ) Remove the nut from the negative (—) battery cable clamp. Slip the terminal of the brown wire over the bolt. Then replace and tighten the nut securely.

( ) In a similar manner, connect the red wire to the positive (+) battery terminal. Tighten the nut securely.

Connecting to Starter Solenoid

( ) Route the 2-wire cable to the starter solenoid. Make sure the cable clears all moving parts and is not near the exhaust manifold. Allow sufficient cable length so the brown wire will reach a good ground on the engine, and the red wire will reach the starter solenoid terminals. Then cut off the excess cable.

( ) Refer to Figure 3 and prepare the end of the 2-wire cable.

( ) Connect the brown wire to a good ground (engine block or starter mounting bolts).

( ) Connect the red wire to the battery terminal of the starter solenoid. This is the terminal to which the positive (+) battery cable is connected.

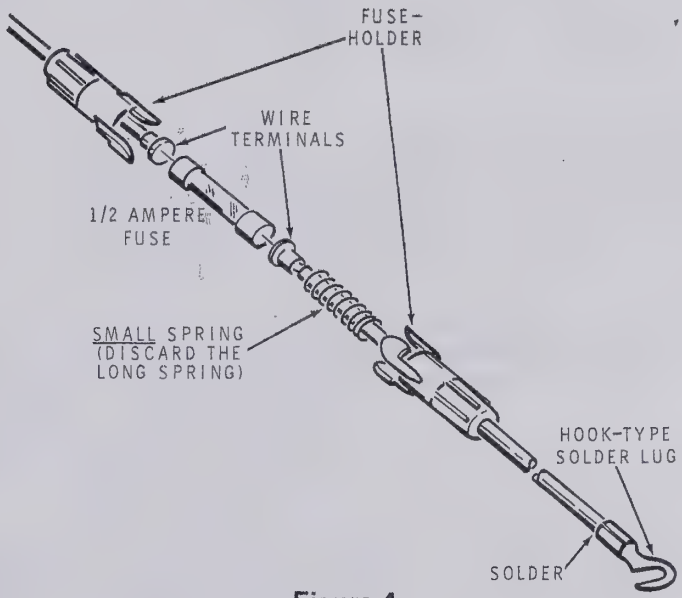


Figure 4

SWITCHING

The relay in the Power Supply is energized by applying 12 volts DC to the relay coil from an external source. All power to the equipment with which the Power Supply is used as well as the power to the Power Supply is controlled by the relay. In effect, the relay is an on-off switch for the entire system.

Some Heathkit Transceiver and Transmitter assembly manuals have specific information for power switching connections to the Power Supply. If you do not have specific directions on this point, use the following procedure.

There are basically two ways to obtain 12 volts DC to control the relay. The first, and preferable way, is from the ignition switch. The second way is directly from the battery. Either source may be used. An in-line fuseholder, a 1/2-ampere fuse, and a hook type solder lug are supplied for this purpose. Prepare the fuseholder as shown in Figure 4.

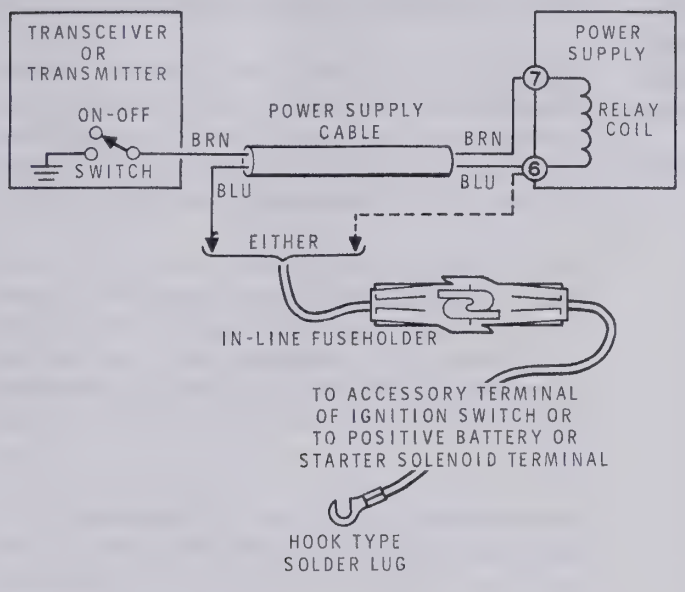


Figure 5

COLOR	VOLTAGE
ORG	+LV*
RED	+12 VDC
WHT	GROUND
BLK	GROUND
GRN	–130 VDC
YEL	+800 VDC
BLU	RELAY
BRN	RELAY

*250 VDC LOW TAP
300 VDC HIGH TAP

Figure 6

The switching hookup is shown in Figure 5. Connect one lead of the fuseholder to the 12-volt DC source; the other lead should be connected to either pin 6 of the 8-wire cable connector, or to the blue wire at the free end of the 8-wire cable.

The relay can be energized by grounding the other side of the relay coil. This is usually accomplished by a simple SPST switch in the transceiver or transmitter with which the Power Supply is used. The brown wire at the free end of the 8-wire cable should be connected to one terminal of the switch. The other switch terminal should be connected to ground. When the switch is closed, it completes the 12 volt DC circuit for the relay coil and energizes the relay. The relay then turns on the complete system.

Figure 6 shows the voltage present at each of the color-coded wires at the free end of the 8-wire cable. Connect these wires to your equipment accordingly.

OVERLOAD PROTECTION

If an overload or short circuit causes one or both of the circuit breakers to "open," the Power Supply must be turned off for approximately 30 seconds. This allows the load delay thermal switch within the circuit breaker to reset and close the circuit again.

IN CASE OF DIFFICULTY

This section of the Manual is divided into two parts. The first part, titled "General Troubleshooting Information," describes what to do about any difficulties that may occur right after the Power Supply is assembled.

The second part, "Resistance Checks," is provided to assist if the "General Information" does not clear up the problem, or if difficulties occur after the Power Supply has been in operation for some time.

GENERAL TROUBLESHOOTING INFORMATION

1. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the builder.

2. About 90% of the kits that are returned to Heath Company for repair do not function properly due to poor connections and soldering. Therefore, many troubles can be eliminated by reheating all connections to make sure that they are soldered as described in the soldering section of the "Kit Builders Guide."

3. Check the values of the parts. Be sure that the proper part has been wired into the circuit, as shown in the Pictorial diagrams and as called out in the wiring instructions.

4. Check for bits of solder, wire ends, or other foreign matter which may be lodged in the wiring.

5. If, after careful checks the trouble is still not located, check voltaged readings against those on the Schematic. NOTE: All voltage readings were taken with an 11 megohm input voltmeter. Voltages shown are with no load on the output.

6. A review of the "Circuit Description," and a study of the Schematic Diagram will help you locate a difficulty in the Power Supply.

7. Check for loose hardware.

NOTE: In an extreme case where you are unable to resolve a difficulty, refer to the "Customer Service" information inside the rear cover of the Manual. Your Warranty is located inside the front cover of the Manual.

RESISTANCE CHECKS

1. Resistance from terminal 1 of the power transformer to chassis ground should be 50-100 Ω. NOTE: This should be measured with an ohmmeter on the RX1 scale. If the reading is below 30 ohms, either Q1, or Q2, or both are shorted. Reversed meter leads should give a reading of approximately 2 Ω.

2. Make forward and reverse resistance checks on diodes D1 through D7. This can be done by using an ohmmeter on the RX1 scale. In one direction the resistance will be 10 Ω; reversing the leads should give a reading of infinity. If the readings vary greatly from the values given, it would indicate that the diode is either open or shorted.

3. Check the circuit breakers for continuity. Also make sure the fiber shoulder washers are properly seated in the circuit breaker bracket.

4. Disconnect one lead of filter choke L1. The resistance of the choke is approximately .6 Ω.

5. Use the ohmmeter to check for continuity between the various transformer windings. NOTE: The transformer leads must be disconnected for this check.

Since the relay is on the on-off switch for the complete system, check its operation. Also check the circuit breakers. Repeated opening of a circuit breaker indicates an overload or short in the circuit supplied through the circuit breaker.

SPECIFICATIONS

Input Voltage	12 to 16 volts DC (negative ground).
Input Current	25 amperes maximum with full load.
Allowable Ambient Temperature	—10 degrees Fahrenheit to 122 degrees Fahrenheit.
High Voltage Output	800 volts DC with no load. 750 volts DC with 250 mA load.
Effective Output Capacitance	10 μF.
Ripple	Less than 1% at 250 mA.
Duty Cycle	Continuous up to 150 mA. 50% up to 300 mA. SSB duty up to 300 mA.
Low Voltage Output (High Tap) 300 volts DC with 150 mA load.	310 volts DC with no load.
Ripple	Less than .05% at 150 mA.
Duty Cycle	Continuous up to 175 mA.
Low Voltage Output (Low Tap)	265 volts DC with no load. 250 volts DC with 150 mA load.
Ripple	Less than .05% at 150 mA.
Duty Cycle	Continuous up to 175 mA.
Bias Voltage	—130 volts DC with 20 mA load.
Duty Cycle	Continuous up to 20 mA.
Switching Frequency	1500 Hz (approximate).
Cabinet Dimensions	7-3/4" wide x 7-5/16" long x 2-3/8" deep.
Net Weight	5-1/4 lbs.

NOTE: A 13.6 volt DC input was used in determining electrical specifications.

The Heath Company reserves the right to discontinue instruments and to change specifications at any time without incurring any obligation to incorporate new features in instruments previously sold.

CIRCUIT DESCRIPTION

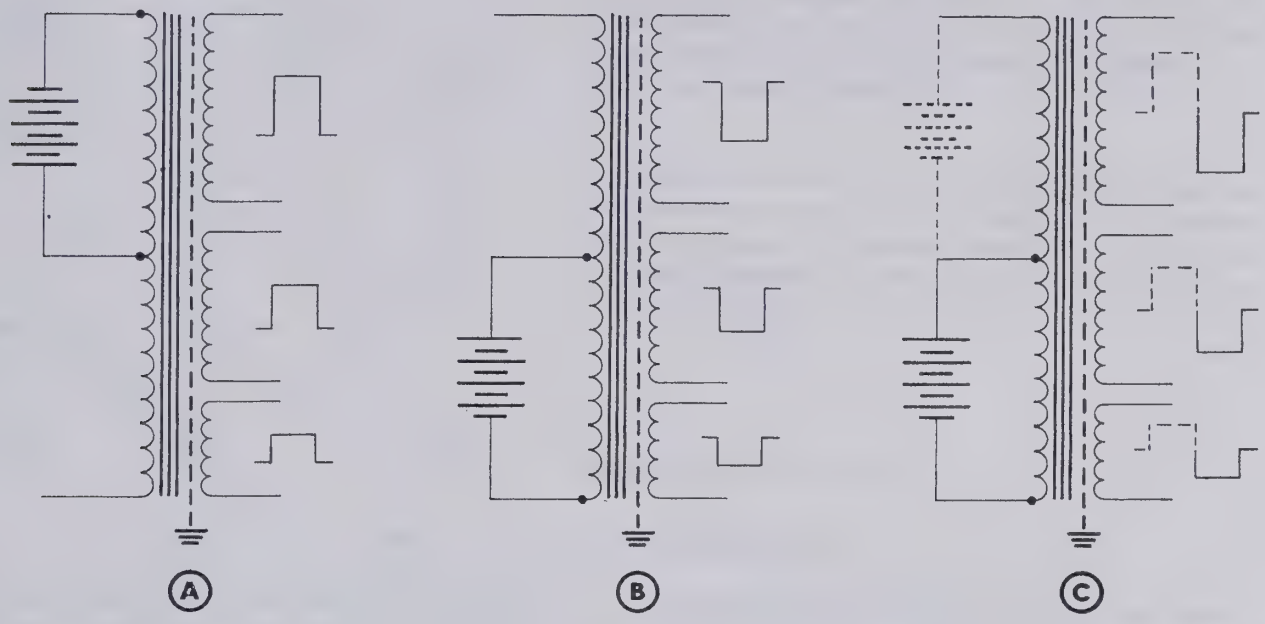


Figure 7

While you read the following "Circuit Description," refer to the Power Supply Schematic and Block Diagrams and to the Figures in the text to obtain a thorough understanding of the circuit operation.

PRIMARY CIRCUIT

The battery voltage available at the 15-terminal input-output connector of the Power Supply is applied through a 40 ampere circuit breaker to the relay contacts. When the relay is energized by external switching of 12 volts DC to the relay coil, this DC voltage is connected through the relay and through a 10-ampere circuit breaker to the filament voltage terminal of the connector. Battery voltage is also applied through suppression choke L2 to the center of the transformer primary winding.

To produce the high DC voltages required to operate mobile electronic equipment, a suitable converter must be used to change battery voltage (DC) to alternating current (AC) for the necessary transformer voltage step-up action. In the Transistorized Power Supply, this conversion is accomplished with two heavy duty transistors which act as switches, and a very efficient toroid power transformer.

The switching action of the transistors is similar to that of a vibrator which uses a contact-carrying, vibrating reed to energize first one half and then the other half of the transformer primary winding. However, a vibrator is an electromechanical switch whose contacts may, after use, become burned and pitted and require replacement of the vibrator.

The two transistors also alternately connect battery voltage across first one half and then the other half of the transformer primary winding. As there are no moving parts involved in this system, mechanical wear is eliminated. Transistors have extremely long life characteristics and require a minimum of maintenance. Transistor switching action is shown in Figures 7A, 7B, and 7C.

The basic converter circuit is shown in Figure 8, which indicates the relative phase and amplitude of the primary and secondary voltages. When power is first applied to the primary circuit, an imbalance will exist between the two transistor circuits due primarily to slight differences in transistor and transformer winding characteristics. This imbalance causes one transistor to momentarily conduct and apply battery voltage across one section of the transformer primary winding, either section A1 or A2 depending upon which transistor is in initial control.

The polarity of the base feedback voltage, with respect to the transformer primary, is such that it drives the "initial control" transistor into very heavy conduction; collector current is several amperes, depending upon the load on the Power Supply output. Degeneration causes the other transistor to be cut off completely.

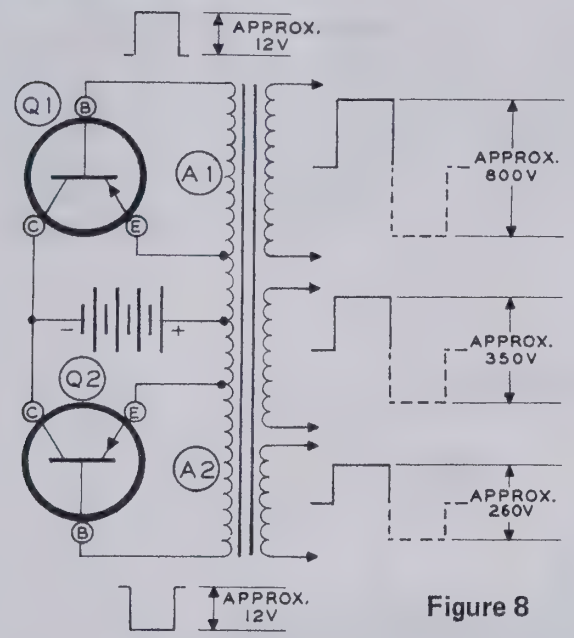


Figure 8

This condition of high current flow will continue until the transformer core reaches saturation. When core saturation occurs, the rate of change of flux approaches zero. The circuit is then unable to maintain the large driving current in the base circuit of the conducting transistor, resulting in a decrease of collector current. This decrease in collector current causes a further decrease of base drive. Circuit feedback is such that continued reduction of base drive causes the conducting transistor to stop conducting (switch off), and the other transistor to begin conducting (switch on).

As the primary circuitry is symmetrical, the operation of the second transistor is identical to that of the initial control transistor. The conditions are duplicated, causing resaturation of the transformer core. This rapid change in core saturation induces a square wave alternating voltage in the transformer secondary windings, in proportion to the turns ratio between the primary and secondary. The cycle will continue to repeat itself and produce the necessary high voltage AC in the transformer secondary windings.

The transistors operate at a nominal switching frequency of 1500 Hz. This frequency represents a good compromise of efficiency, filtering, and operating temperatures. At higher frequencies, the time required for the transistors to switch on and off is a large portion of the operating cycle; this results in low efficiency. At lower frequencies, larger value filter capacitors would be required and a much larger transformer would be needed. The switching frequency is determined by a number of factors, including transistor circuit values, and transformer and transistor characteristics.

The transformer used in this Power Supply is a very efficient toroid type, designed to operate at a frequency of approximately 1500 Hz. The transformer will run relatively warm even under no load. This condition is normal for a transformer operated near or in a saturated condition.

Transistors used in this type of switching application operate at high current during one-half of each cycle. The transistor heat which occurs is effectively dissipated by radiation from the heat sink assemblies, which are cooled by air circulating around the heat sink fins.

SECONDARY CIRCUIT

High Voltage Section

The high voltage DC section uses a full-wave voltage-doubler circuit, consisting of diodes D1, D2, D3, and D4 with capacitors C3 and C4. A voltage-doubler circuit produces a DC output of approximately twice the peak value of the alternating voltage available at the secondary winding of the transformer. Diodes D1 and D2 rectify one-half cycle of voltage, and D3 and D4 rectify the other half cycle. On alternate half cycles, capacitors C3 and C4 charge to the approximate value of the AC voltage appearing across the transformer secondary winding. The polarity is such that the DC voltages developed across these two capacitors add together; this "doubled" DC voltage appears between ground and the junction of D4, C3, and R3. Capacitors C3 and C4 with resistors R3 and R4 provide filtering. R3 and R4 also act as bleeder resistors to provide a discharge path for the voltage doubler capacitors when the power supply is turned off.

Buffer capacitor C2 absorbs transient voltage surges that occur in the secondary winding as a result of transistor switching action in the primary circuit.

Low Voltage Section

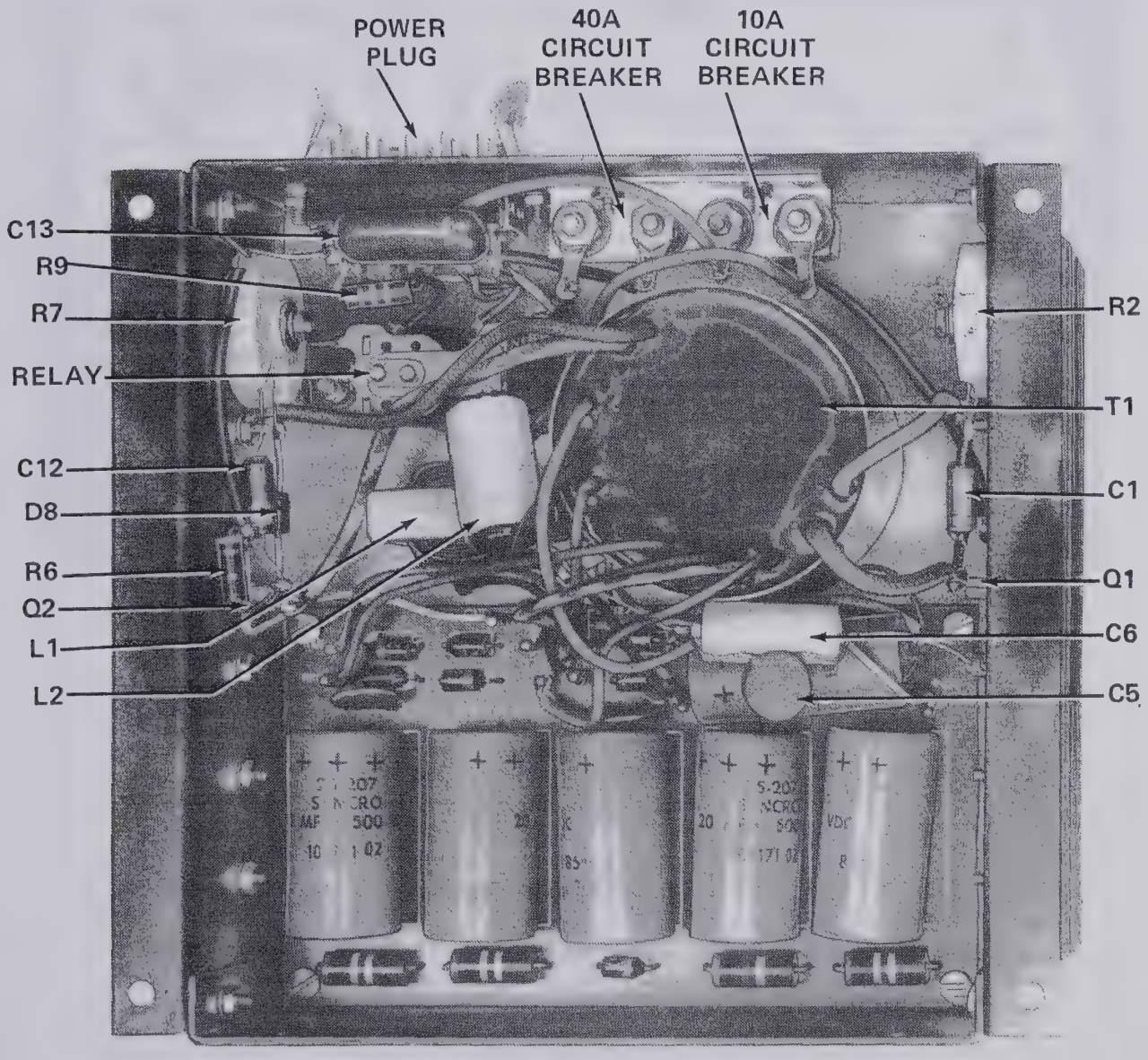
The low voltage DC section also uses a fullwave voltage-doubler circuit, made up of diodes D5 and D6 with capacitors C8 and C10. Capacitors C8, C9, and C10 with choke L1 filter the DC output voltage, which is then applied to the Power Supply connector. R5 is a bleeder resistor, and C7 is a buffer capacitor.

The low voltage secondary winding is tapped to provide a choice of two different output voltages. Either the blue-green or the blue-yellow transformer lead may be connected to the voltage-doubler circuit. The blue-green lead provides the higher output voltage. The choice of output voltages depends on the requirements of the equipment with which the Power Supply is used.

Bias Section

The bias voltage section uses diode D7 as a half-wave rectifier. The filter network consists of capacitors C11A and C11B with resistor R8. Resistor R9 is a bleeder resistor.

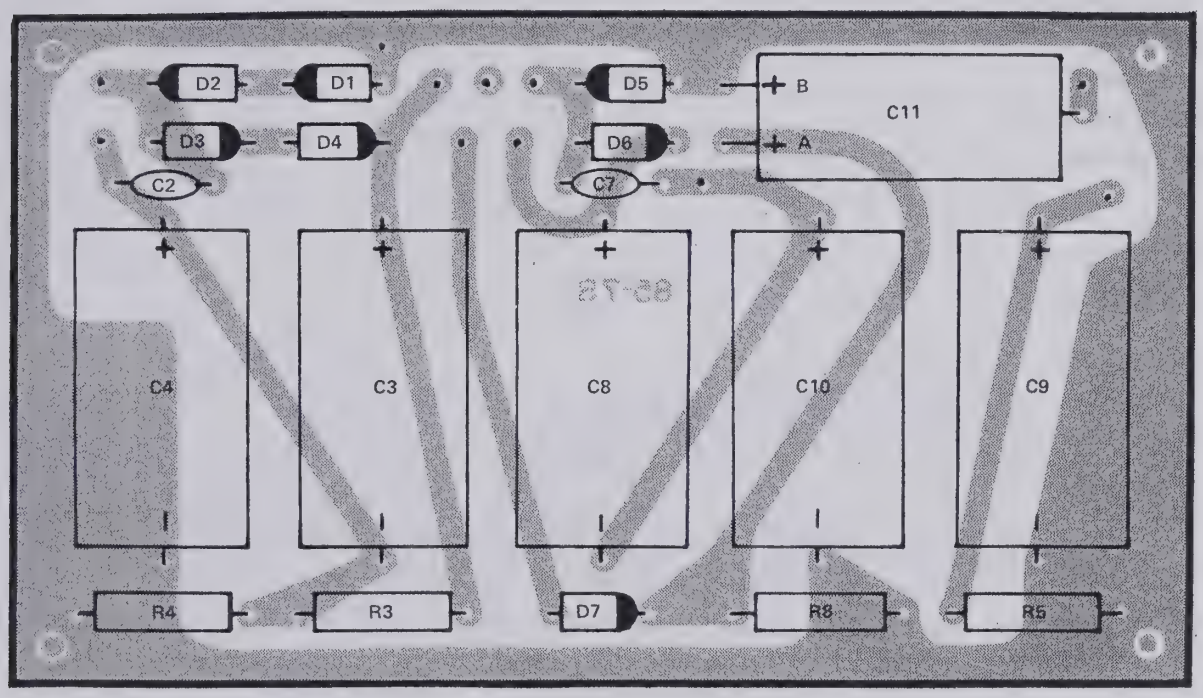
CHASSIS PHOTOGRAPH



X-RAY VIEW

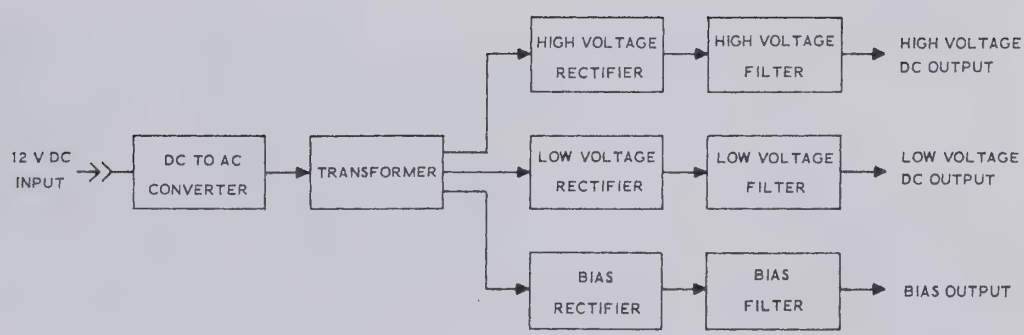
NOTE: To identify a part shown in one of these Views, so you can order a replacement, proceed as follows:

1. Note the identification number of the part (R-number, C-number, etc.).
2. Locate the same identification number (next to the part) on the Schematic. The "Description" of the part (for example: 22 kΩ, .05 μF, or 2N2712) will also appear near the part.
3. Look up this Description in the Parts List.

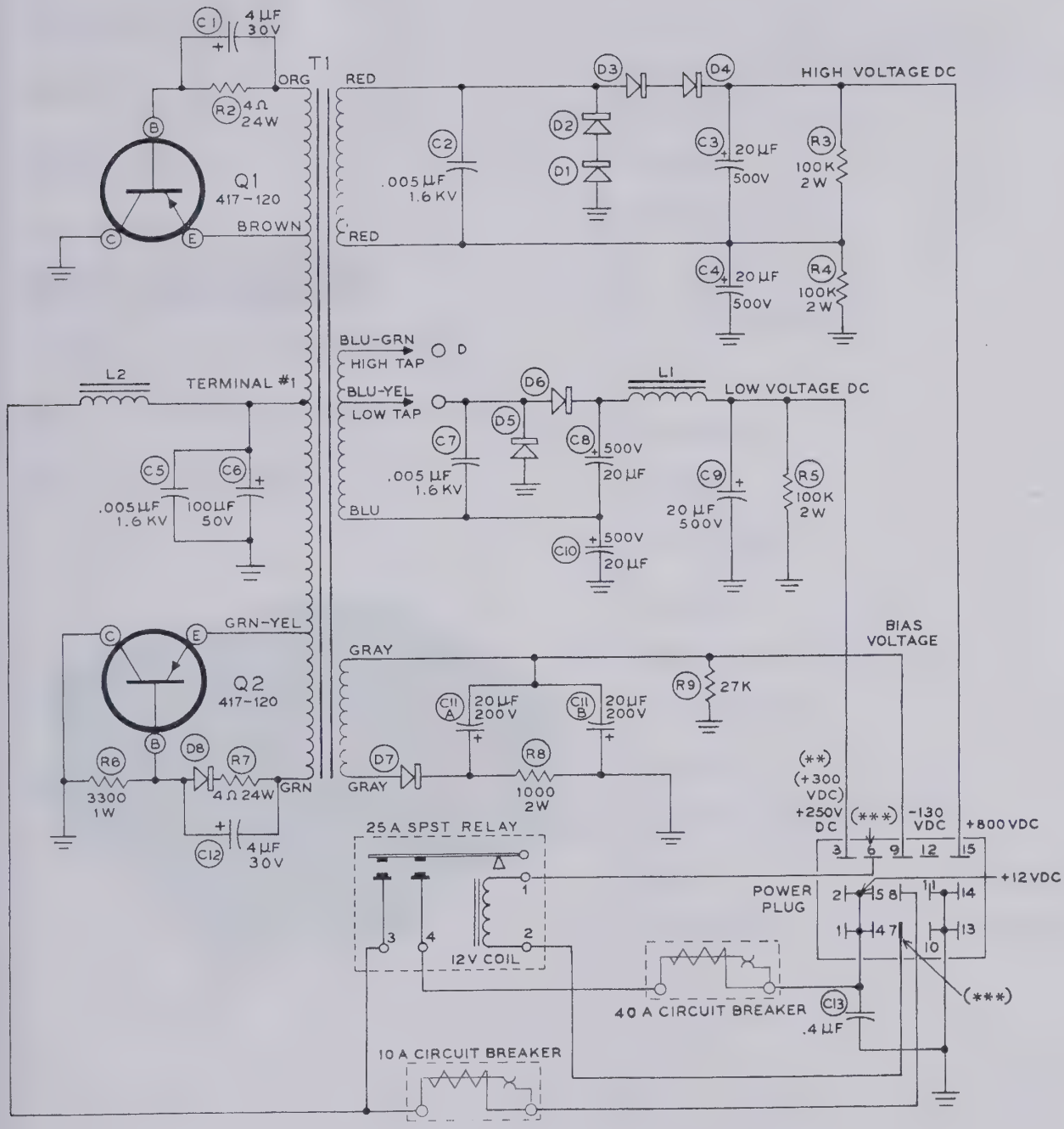


(Shown from component side)

SCHEMATIC OF THE
HEATHKIT®
TRANSISTORIZED
DC POWER SUPPLY
MODEL HP-13B



BLOCK DIAGRAM



SISTANCES IN OHMS (K=1000, M=1,000,000).

LTAGES MEASURED FROM INDICATED POINT TO CHASSIS D.

PLUG TERMINALS VIEWED FROM INSIDE OF CHASSIS. R LETTER-NUMBER DESIGNATIONS SHOWN ON CHASSIS GRAPHS AND CIRCUIT BOARD X-RAY VIEW.

(* *) +250 V DC LOW TAP.
+300 V DC HIGH TAP.

(***) LUG #6 AND/OR LUG #7 MAY HAVE 12 VDC WITH RESPECT TO GROUND, DEPENDING UPON THE SPECIFIC CIRCUITRY AND CONNECTIONS OF THE EQUIPMENT USED WITH THE POWER SUPPLY.

CONDENSED

Assembly and Operation of the HEATHKIT TRANSISTORIZED DC POWER SUPPLY

MODEL HP-13B

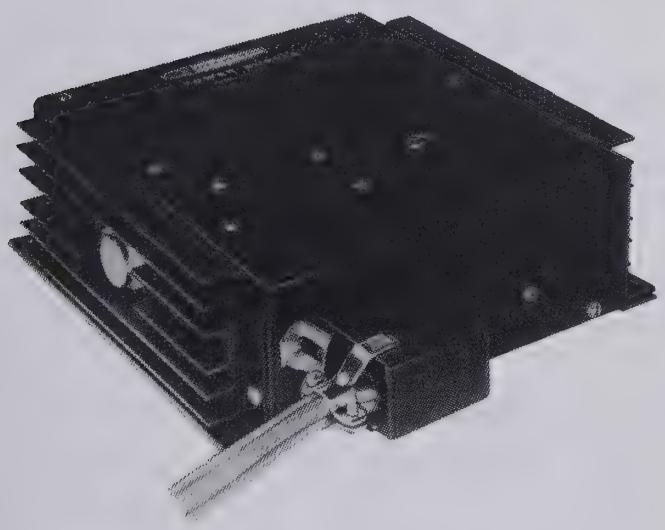


TABLE OF CONTENTS

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

INTRODUCTION

The Heathkit Model HP-13B Transistorized DC Power Supply was designed to furnish all necessary operating power for Heathkit Mobile Amateur Transmitters, Transceivers, and Receivers, as well as for other brands of mobile equipment.

This Power Supply is actually three DC power sources in one unit. It provides high voltage (750 volts), low voltage (300 or 250 volts), and bias voltage (—130 volts). It also switches DC filament voltage for the equipment with which it is used.

Circuit features include relay control of all primary power, plus individual circuit breaker protection of the DC input to the Power Supply and of the DC filament voltage line to the equipment used with the Power Supply. The circuit breakers are the automatic reset, load delay type. They insure positive protection for all equipment involved in case of an overload or accidental short circuit.

The power transformer, an epoxy encapsulated toroid unit is of advanced design, assuring maximum efficiency. This transformer, in conjunction with the power transistors used as a DC-to-AC converter, provides a high frequency switching rate along with high power and instant starting. Specially designed heat sink assemblies provide maximum transistor cooling.

Efficient, long life silicon rectifiers and heavy-duty filter capacitors, mounted on a rugged circuit board, provide trouble-free rectification and filtering.

Because the complete Power Supply is physically small, it requires a minimum of mounting space. Under-the-hood mounting is recommended.

Read the "Kit Builders Guide" for complete information on unpacking, parts identification, tools, wiring, soldering, and step-by-step assembly procedures.

PARTS LIST

Check each part against the following list. The key numbers correspond to numbers on the Parts Pictorial (fold-out from Page 3).

To order replacement parts use the Parts Order Form furnished with this kit. If a Parts Order Form is not available, refer to the "Parts Replacement" inside the rear cover of the Manual.

Any part that is packaged in an individual envelope with a part number on it should be placed back in its envelope after it is identified, until that part is called for in a step.

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
RESISTORS				
A1	1-3-1	1	3300 Ω (orange-orange-red), 1-watt	.10
A1	1-46-1	1	27 kΩ (red-violet-orange), 1-watt	.10
A2	1-15-2	1	1000 Ω (brown-black-red), 2-watt	.15
A2	1-24-2	3	100 kΩ (brown-black-yellow), 2-watt	.15
A3	3-1-24	2	4 Ω, 24-watt, ceramic	.95
CAPACITORS				
B1	21-35	3	.005 μF 1.6 kV disc	.15
B2	25-254	2	4 μF electrolytic	.50
B3	25-206	1	20-20 μF electrolytic	.85
B4	25-207	5	20 μF electrolytic	.85
B4	25-28	1	100 μF electrolytic	.60
B5	27-20	1	.4 μF Mylar*	.30

*DuPont Registered Trademark

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
CIRCUIT BREAKERS-RELAY-CHOKES-TRANSFORMER				
C1	65-20	1	10-ampere circuit breaker	.80
C1	65-16	1	40-ampere circuit breaker	.80
C2	69-68	1	12-volt relay	5.00
C3	45-59	1	Suppression choke	.60
C4	46-24	1	Filter choke	1.30
C5	54-144	1	Power transformer	27.95
DIODES-TRANSISTORS				
D1	57-27	7	Silicon diode, 600V, 1A (1N2071)	.50
D1	57-42	1	Silicon diode, 100V, 3A (3A1)	1.15
D2	417-120	2	Power transistor	5.00
FUSEHOLDER-PLUG-CABLE CONNECTOR				
E1	423-10	1	In-line fuseholder	.50
E2	432-34	1	15-contact plug	1.20
E3	432-35	1	15-contact connector	2.10
METAL PARTS				
F1	200-633-1	1	Chassis	2.50
F2	204-549	1	Circuit breaker mounting bracket	.15
F3	205-417-1	1	Bottom plate	.85
F4	215-11-1	2	Heat sink (bottom section)	.60
F5	215-12-1	2	Heat sink (middle section)	.25
F6	215-13-1	4	Heat sink (top section)	.15
HARDWARE				
#6 Hardware				
G1	250-235	8	6-32 x 1/4" screw	.05
G2	250-233	12	6-32 x 3/8" screw	.05
G3	250-234	10	6-32 x 1/2" screw	.05
G4	250-364	2	6-32 x 7/8" screw	.05
G5	250-237	4	#6 x 3/8" sheet metal screw	.05
G6	252-77	24	6-32 nut	.05
G7	253-96	2	#6 flat washer	.05
G8	254-25	26	#6 lockwasher	.05
G9	259-1	4	#6 solder lug	.05
G10	255-23	4	#6 threaded spacer	.05

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
#10 Hardware				
G11	250-83	4	#10 x 1/2" sheet metal screw	.05
G12	252-63	8	10-32 nut	.05
G13	253-3	4	#10 fiber flat washer	.05
G14	253-7	4	#10 fiber shoulder washer	.05
G15	254-36	1	#10 lockwasher	.10
G16	259-5	4	#10 solder lug	.05
MISCELLANEOUS				
	85-78-2	1	Circuit board	1.80
H1	259-15	1	Hook type solder lug	.05
H2	259-20	2	Circuit board solder terminal	.05
H3	262-8	9	Circuit board solder pin	.05
H4	259-21	2	5/16" solder lug	.05
H5	260-32	2	Cable connector clip lock	.30
	344-2	1	Black wire	.05/ft
	346-2	1	Large sleeving	.05/ft
	347-13	1	2-wire cable	.15/ft
	347-52	1	8-wire cable	.60/ft
	421-13	1	1/2-ampere fuse	.15
	490-5	1	Nut starter	.10
	391-34	1	Blue and white identification label	
	597-260	1	Parts Order Form	
	597-308	1	Kit Builders Guide	
		1	Manual (See front cover for part number.)	2.00
			Solder (Additional 3' rolls of solder, #331-6, can be ordered for 15 cents each.)	

The above prices apply only on purchases from the Heath Company where shipment is to a U.S.A. destination. Add 10% (minimum 25 cents) to the price when ordering from a Heathkit Electronic Center to cover local sales tax, postage, and handling. Outside the U.S.A. parts and service are available from your local Heathkit source and will reflect additional transportation, taxes, duties, and rates of exchange.

( ) Blue lead to the circuit board pin marked BLUE (S-1).

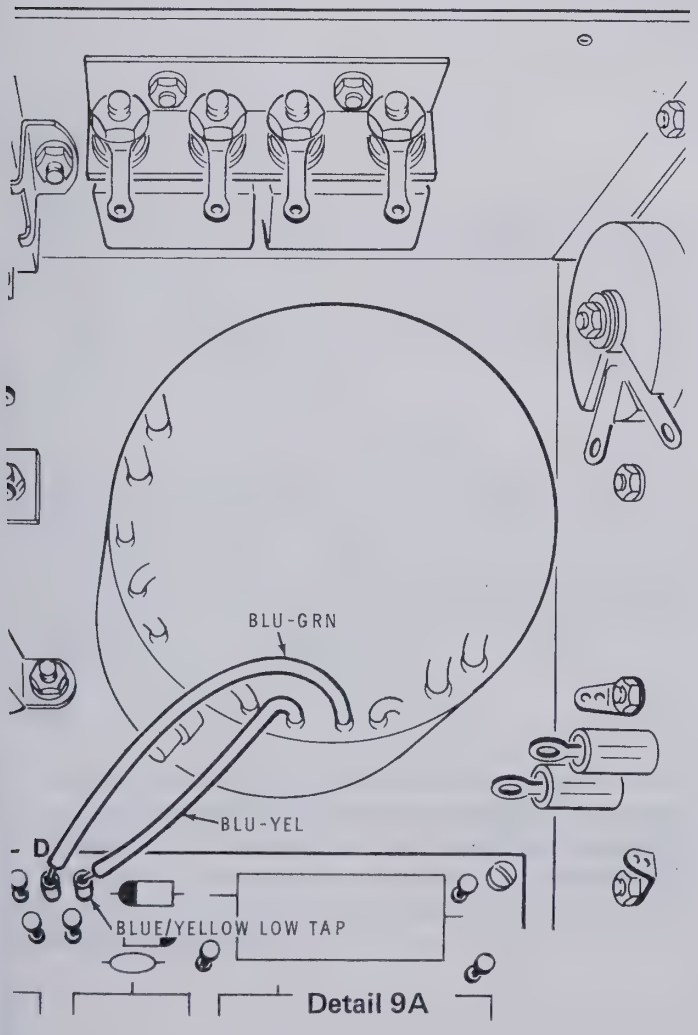
( ) 6" gray lead to the circuit board pin marked BIAS (S-2).

( ) Green-yellow lead to lug 2 of transistor AE (S-1).

( ) Green lead to lug 1 of resistor AH (S-2). Wrap this lead around the resistor lug.

( ) Carefully inspect the lugs of the resistors at CB and AH. Make sure the lugs do not touch the screws at CC and AG respectively.

IMPORTANT: The low voltage output circuit has two voltage values available. The low tap output is 250 volts DC. The high tap output is 300 volts DC. Determine which of these voltages is required for the equipment with which you plan to use the Power Supply. Then proceed to the steps for the voltage value you have selected. Terminal D on the circuit board is a "dummy" terminal. (Make sure the leads are soldered to the terminals and that the terminals are soldered to the circuit board.)



Detail 9A

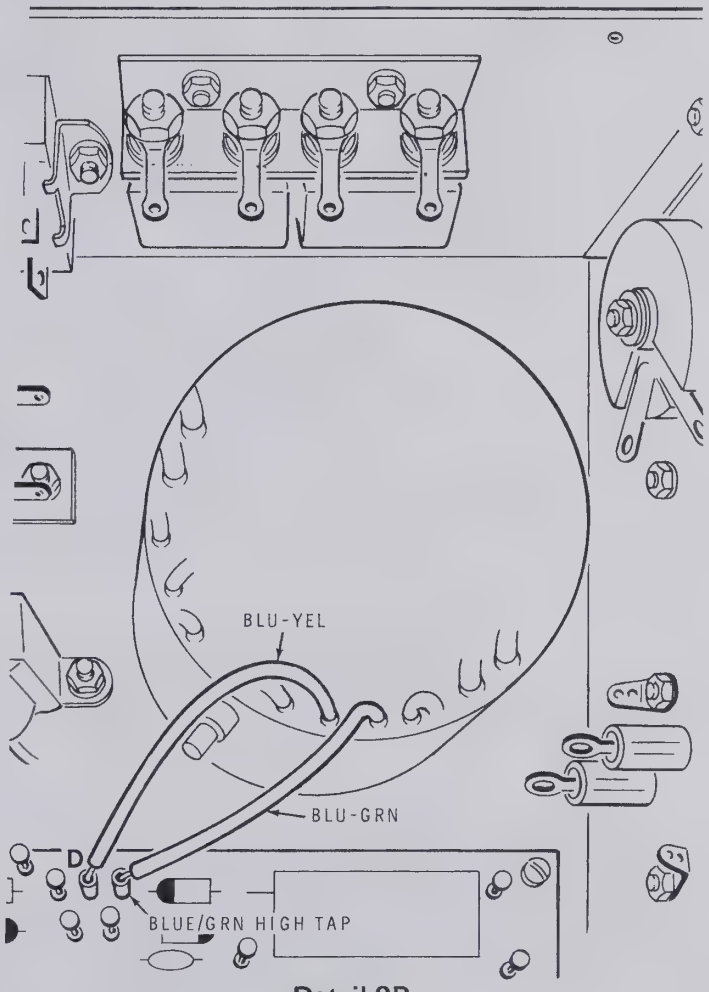
For 250-Volt DC Output

Refer to Detail 9A for the following steps.

( ) Blue-yellow lead to the solder terminal marked BLUE/YELLOW LOW TAP (S-1).

( ) Blue-green lead to the solder terminal marked D (S-1).

Proceed to "Cable Preparation."



Detail 9B

For 300-Volt DC Output

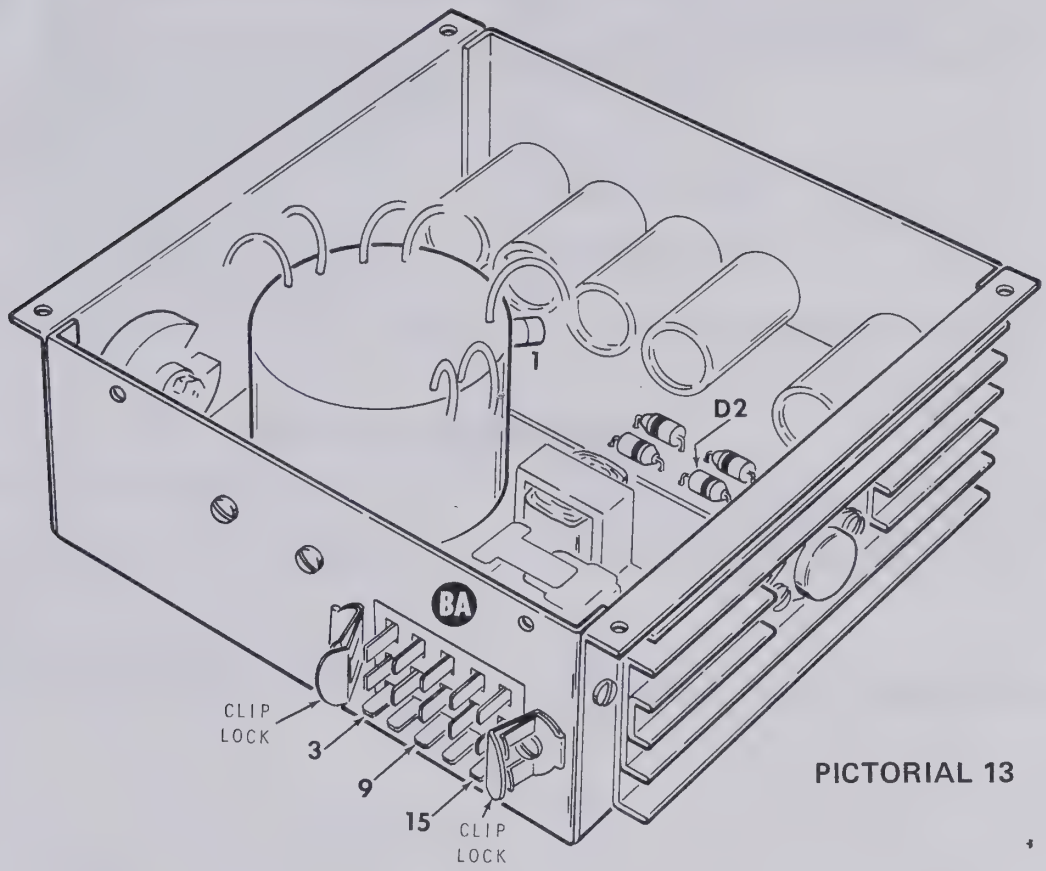
Refer to Detail 9B for the following steps.

( ) Blue-green lead to the solder terminal marked BLUE/GRN HIGH TAP (S-1).

( ) Blue-yellow lead to the solder terminal marked D (S-1).

Proceed to "Cable Preparation."

INITIAL TESTS



PICTORIAL 13

To avoid possible damage, it is important that you use an ohmmeter to make the following resistance checks before you connect or turn on the Power Supply. If you cannot obtain the proper ohmmeter indication in the following steps, refer to the "In Case of Difficulty" section. DO NOT turn on the Power Supply until the difficulty has been corrected.

NOTE: Use a vaccum tube voltmeter (VTVM) or a volt-ohmmeter (VOM) to make the resistance check in the following steps (solid-state ohmmeters do not furnish a voltage high enough to make the diodes conduct in the circuit being tested). Make sure you have the ohmmeter set correctly, since the range setting influences the meter reading when a diode is in the circuit.

( ) Set the ohmmeter to the RX1 range.

Because some of the circuits to be measured contain diodes, you will obtain different resistance readings if the polarity of the meter leads is reversed in the following measurements. Therefore, in the next two steps you will determine the polarity of the ohmmeter test leads and connect the proper lead to chassis ground.

Refer to Pictorial 13 for the following steps.

( ) Make sure the clip locks do not touch any lugs of connector BA. If necessary, bend the clip locks back slightly.

( ) Connect the negative meter lead to the banded end of diode D2. Connect the positive meter lead to the other diode lead. If the resistance is approximately 10 ohms, connect the negative meter lead to the chassis (ground) for the following resistance checks and disregard the next step.

( ) If the meter needle remains on or near the infinity mark (full scale), reverse the meter leads. If you now obtain a reading of approximately 10 ohms, connect the positive meter lead to the chassis (ground) for the following resistance checks.

Make the resistance checks in the following chart from chassis ground to the indicated points. Some of the readings will take a few seconds to reach the specified resistance because of the slow charging rate of the capacitor in the Power Supply.

DO THIS:	THE RESISTANCE SHOULD BE:
( ) Measure terminal 1 on the transformer.	25 Ω or greater.
( ) Set the ohmmeter to the RX10k range.	
( ) Measure pin 3 of connector BA.	100 kΩ or greater.
( ) Measure pin 15 of connector BA.	200 kΩ or greater.
( ) Reverse the ohmmeter leads.	
( ) Measure pin 9 of connector BA.	25 kΩ or greater.
( ) Disconnect the ohmmeter leads.	

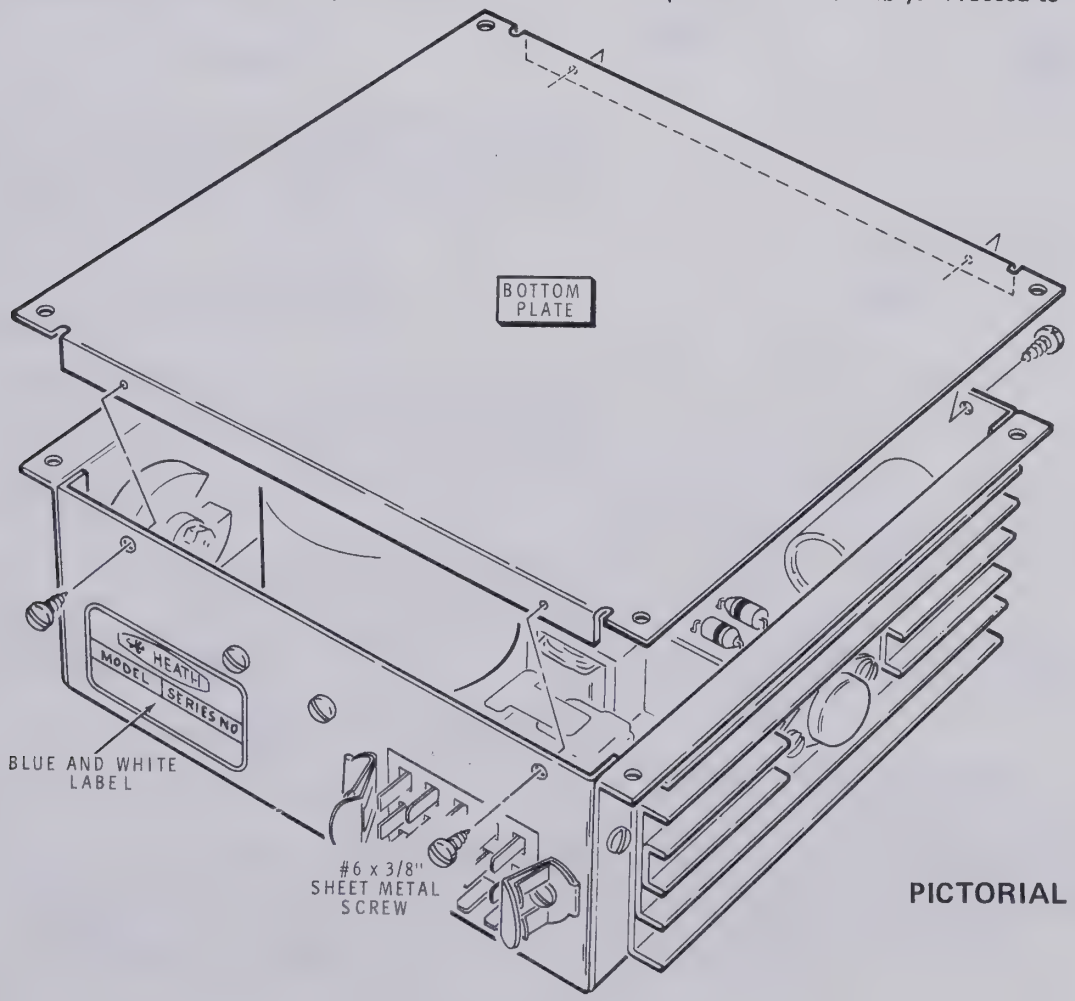
FINAL ASSEMBLY

Refer to Pictorial 14 for the following steps.

( ) Install the bottom plate on the chassis. Use four #6 x 3/8" sheet metal screws.

( ) Carefully peel away the paper backing from the blue and white identification label. Then press the label on the chassis at the location shown. Be sure to refer to the numbers on this label in any communications you have with the Heath Company about this kit.

This completes "Final Assembly." Proceed to "Installation."



PICTORIAL 14

INSTALLATION

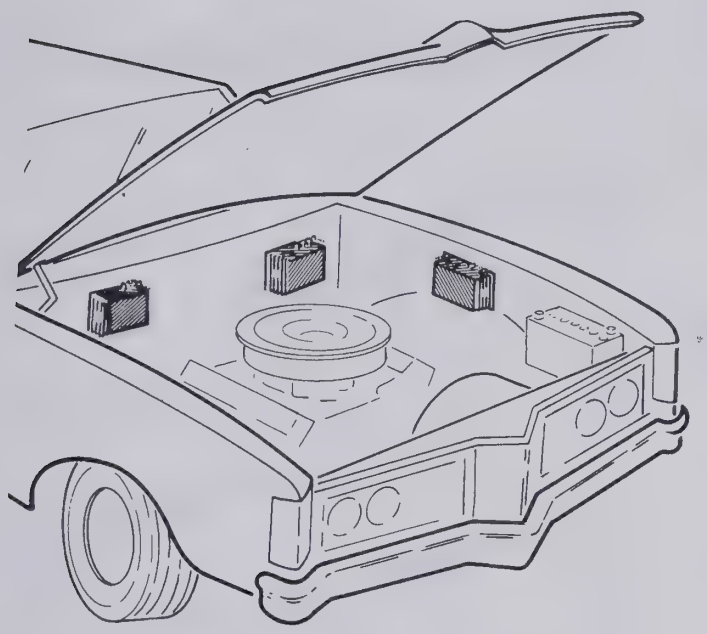


Figure 1

WARNING: Before you install this Power Supply in a vehicle, measure the generator or alternator output voltage. The voltage output of the charging system MUST NOT EXCEED 16 VOLTS.

MOUNTING CONSIDERATIONS

It is recommended that you mount the Power Supply under the hood. Figure 1 shows several possible under-the-hood mounting locations. Choose the location that is best for your particular installation and allows adequate ventilation and protection from water spray.

Mount the Power Supply as near to the vehicle battery or starter solenoid as practical. This will allow the 2-wire battery cable to be connected to either of these two points by the shortest route possible.

It is preferable that you mount the Power Supply with the heat sink fins vertical to provide maximum cooling of the transistor. However, this is not mandatory.

( ) When you have decided upon the mounting position, use the Power Supply as a template and mark the four hole locations on the chassis. See Figure 2. Drill a 9/64" hole at each of these four points.

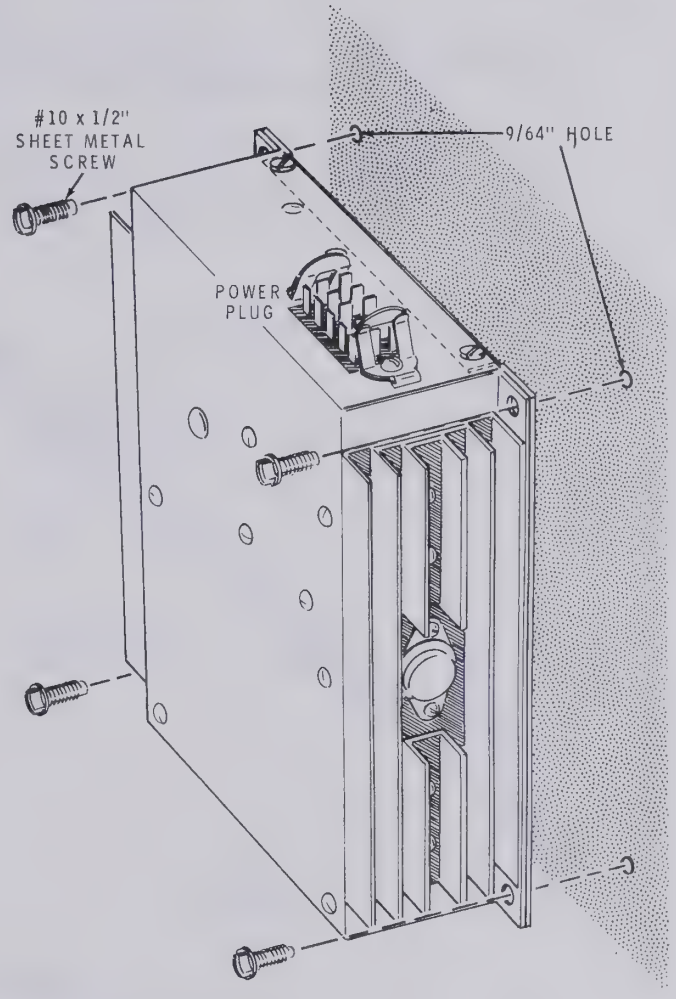


Figure 2

( ) Refer to Figure 2 and mount the Power Supply at the prepared location. Start four #10 x 1/2" sheet metal screws into the mounting surface; then tighten them securely.

( ) Attach the power cable connector to the connector on the chassis. Be sure the connectors are coupled firmly together.

BATTERY CONNECTIONS

NOTE: If the vehicle battery cables terminate in spring connectors, connect the 2-wire cable to the starter solenoid instead of the battery. Follow the directions for the specific conditions you encounter.

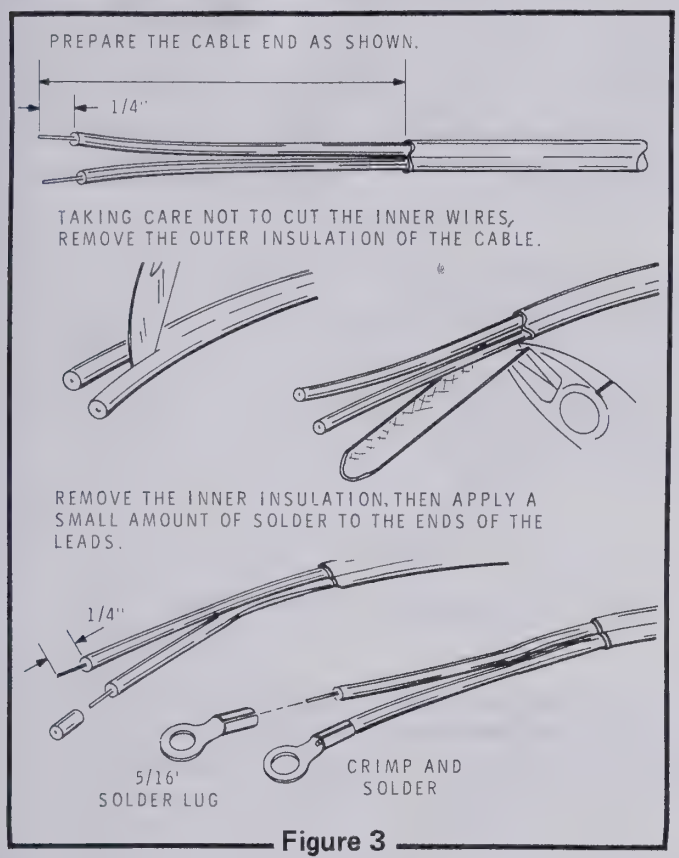


Figure 3

Connecting to Battery

( ) Route the 2-wire cable to the battery. Make sure the cable clears all moving parts and is not near the exhaust manifold. Allow sufficient cable length so the wires can be connected to the battery terminals. Then cut off the excess cable.

( ) Refer to Figure 3 and prepare the end of the 2-wire cable.

( ) Remove the nut from the negative (—) battery cable clamp. Slip the terminal of the brown wire over the bolt. Then replace and tighten the nut securely.

( ) In a similar manner, connect the red wire to the positive (+) battery terminal. Tighten the nut securely.

Connecting to Starter Solenoid

( ) Route the 2-wire cable to the starter solenoid. Make sure the cable clears all moving parts and is not near the exhaust manifold. Allow sufficient cable length so the brown wire will reach a good ground on the engine, and the red wire will reach the starter solenoid terminals. Then cut off the excess cable.

( ) Refer to Figure 3 and prepare the end of the 2-wire cable.

( ) Connect the brown wire to a good ground (engine block or starter mounting bolts).

( ) Connect the red wire to the battery terminal of the starter solenoid. This is the terminal to which the positive (+) battery cable is connected.

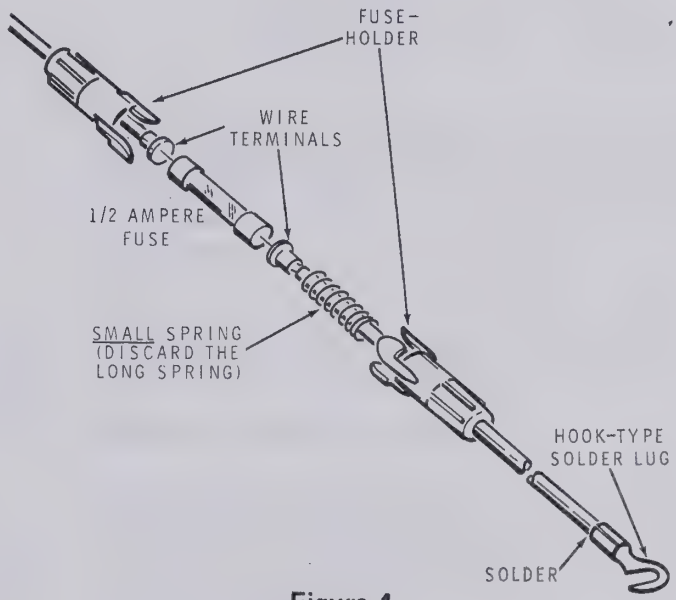


Figure 4

SWITCHING

The relay in the Power Supply is energized by applying 12 volts DC to the relay coil from an external source. All power to the equipment with which the Power Supply is used as well as the power to the Power Supply is controlled by the relay. In effect, the relay is an on-off switch for the entire system.

Some Heathkit Transceiver and Transmitter assembly manuals have specific information for power switching connections to the Power Supply. If you do not have specific directions on this point, use the following procedure.

There are basically two ways to obtain 12 volts DC to control the relay. The first, and preferable way, is from the ignition switch. The second way is directly from the battery. Either source may be used. An in-line fuseholder, a 1/2-ampere fuse, and a hook type solder lug are supplied for this purpose. Prepare the fuseholder as shown in Figure 4.

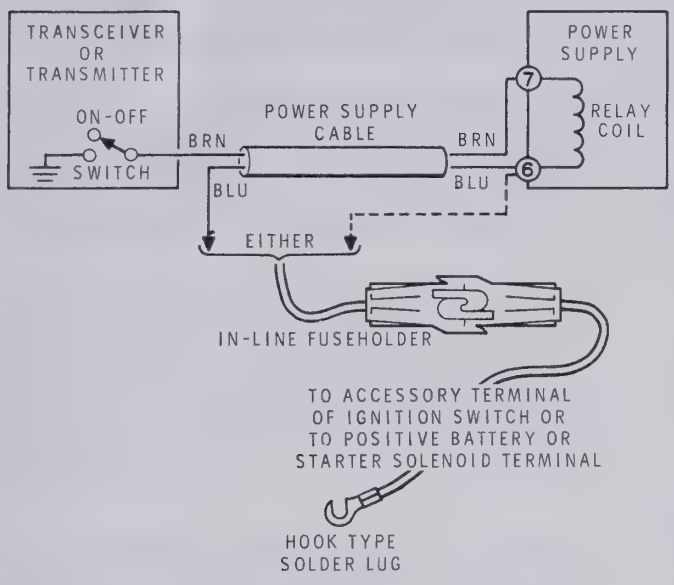


Figure 5

COLOR	VOLTAGE
ORG	+LV*
RED	+12 VDC
WHT	GROUND
BLK	GROUND
GRN	–130 VDC
YEL	+800 VDC
BLU	RELAY
BRN	RELAY

*250 VDC LOW TAP
300 VDC HIGH TAP

Figure 6

The switching hookup is shown in Figure 5. Connect one lead of the fuseholder to the 12-volt DC source; the other lead should be connected to either pin 6 of the 8-wire cable connector, or to the blue wire at the free end of the 8-wire cable.

The relay can be energized by grounding the other side of the relay coil. This is usually accomplished by a simple SPST switch in the transceiver or transmitter with which the Power Supply is used. The brown wire at the free end of the 8-wire cable should be connected to one terminal of the switch. The other switch terminal should be connected to ground. When the switch is closed, it completes the 12 volt DC circuit for the relay coil and energizes the relay. The relay then turns on the complete system.

Figure 6 shows the voltage present at each of the color-coded wires at the free end of the 8-wire cable. Connect these wires to your equipment accordingly.

OVERLOAD PROTECTION

If an overload or short circuit causes one or both of the circuit breakers to "open," the Power Supply must be turned off for approximately 30 seconds. This allows the load delay thermal switch within the circuit breaker to reset and close the circuit again.

IN CASE OF DIFFICULTY

This section of the Manual is divided into two parts. The first part, titled "General Troubleshooting Information," describes what to do about any difficulties that may occur right after the Power Supply is assembled.

The second part, "Resistance Checks," is provided to assist if the "General Information" does not clear up the problem, or if difficulties occur after the Power Supply has been in operation for some time.

GENERAL TROUBLESHOOTING INFORMATION

1. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the builder.

2. About 90% of the kits that are returned to Heath Company for repair do not function properly due to poor connections and soldering. Therefore, many troubles can be eliminated by reheating all connections to make sure that they are soldered as described in the soldering section of the "Kit Builders Guide."

3. Check the values of the parts. Be sure that the proper part has been wired into the circuit, as shown in the Pictorial diagrams and as called out in the wiring instructions.

4. Check for bits of solder, wire ends, or other foreign matter which may be lodged in the wiring.

5. If, after careful checks the trouble is still not located, check voltaged readings against those on the Schematic. NOTE: All voltage readings were taken with an 11 megohm input voltmeter. Voltages shown are with no load on the output.

6. A review of the "Circuit Description," and a study of the Schematic Diagram will help you locate a difficulty in the Power Supply.

7. Check for loose hardware.

NOTE: In an extreme case where you are unable to resolve a difficulty, refer to the "Customer Service" information inside the rear cover of the Manual. Your Warranty is located inside the front cover of the Manual.

RESISTANCE CHECKS

1. Resistance from terminal 1 of the power transformer to chassis ground should be 50-100 Ω. NOTE: This should be measured with an ohmmeter on the RX1 scale. If the reading is below 30 ohms, either Q1, or Q2, or both are shorted. Reversed meter leads should give a reading of approximately 2 Ω.

2. Make forward and reverse resistance checks on diodes D1 through D7. This can be done by using an ohmmeter on the RX1 scale. In one direction the resistance will be 10 Ω; reversing the leads should give a reading of infinity. If the readings vary greatly from the values given, it would indicate that the diode is either open or shorted.

3. Check the circuit breakers for continuity. Also make sure the fiber shoulder washers are properly seated in the circuit breaker bracket.

4. Disconnect one lead of filter choke L1. The resistance of the choke is approximately .6 Ω.

5. Use the ohmmeter to check for continuity between the various transformer windings. NOTE: The transformer leads must be disconnected for this check.

Since the relay is on the on-off switch for the complete system, check its operation. Also check the circuit breakers. Repeated opening of a circuit breaker indicates an overload or short in the circuit supplied through the circuit breaker.

SPECIFICATIONS

Input Voltage	12 to 16 volts DC (negative ground).
Input Current	25 amperes maximum with full load.
Allowable Ambient Temperature	—10 degrees Fahrenheit to 122 degrees Fahrenheit.
High Voltage Output	800 volts DC with no load. 750 volts DC with 250 mA load.
Effective Output Capacitance	10 μF.
Ripple	Less than 1% at 250 mA.
Duty Cycle	Continuous up to 150 mA. 50% up to 300 mA. SSB duty up to 300 mA.
Low Voltage Output (High Tap) 300 volts DC with 150 mA load.	310 volts DC with no load.
Ripple	Less than .05% at 150 mA.
Duty Cycle	Continuous up to 175 mA.
Low Voltage Output (Low Tap)	265 volts DC with no load. 250 volts DC with 150 mA load.
Ripple	Less than .05% at 150 mA.
Duty Cycle	Continuous up to 175 mA.
Bias Voltage	—130 volts DC with 20 mA load.
Duty Cycle	Continuous up to 20 mA.
Switching Frequency	1500 Hz (approximate).
Cabinet Dimensions	7-3/4" wide x 7-5/16" long x 2-3/8" deep.
Net Weight	5-1/4 lbs.

NOTE: A 13.6 volt DC input was used in determining electrical specifications.

The Heath Company reserves the right to discontinue instruments and to change specifications at any time without incurring any obligation to incorporate new features in instruments previously sold.

CIRCUIT DESCRIPTION

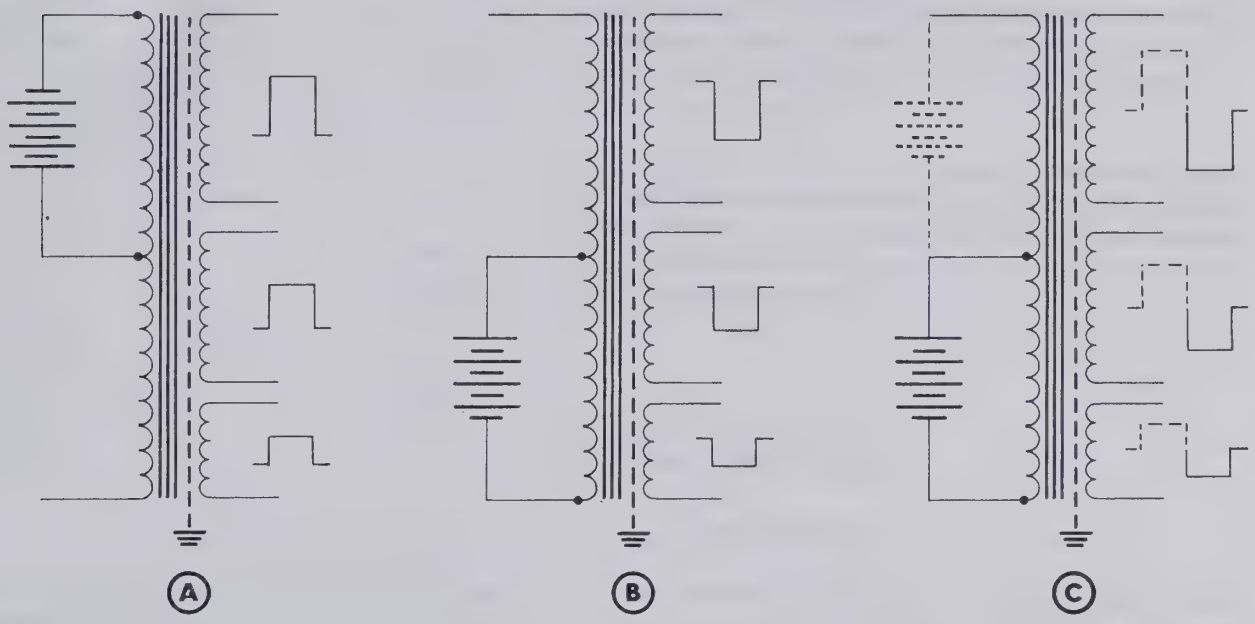


Figure 7

While you read the following "Circuit Description," refer to the Power Supply Schematic and Block Diagrams and to the Figures in the text to obtain a thorough understanding of the circuit operation.

PRIMARY CIRCUIT

The battery voltage available at the 15-terminal input-output connector of the Power Supply is applied through a 40 ampere circuit breaker to the relay contacts. When the relay is energized by external switching of 12 volts DC to the relay coil, this DC voltage is connected through the relay and through a 10-ampere circuit breaker to the filament voltage terminal of the connector. Battery voltage is also applied through suppression choke L2 to the center of the transformer primary winding.

To produce the high DC voltages required to operate mobile electronic equipment, a suitable converter must be used to change battery voltage (DC) to alternating current (AC) for the necessary transformer voltage step-up action. In the Transistorized Power Supply, this conversion is accomplished with two heavy duty transistors which act as switches, and a very efficient toroid power transformer.

The switching action of the transistors is similar to that of a vibrator which uses a contact-carrying, vibrating reed to energize first one half and then the other half of the transformer primary winding. However, a vibrator is an electromechanical switch whose contacts may, after use, become burned and pitted and require replacement of the vibrator.

The two transistors also alternately connect battery voltage across first one half and then the other half of the transformer primary winding. As there are no moving parts involved in this system, mechanical wear is eliminated. Transistors have extremely long life characteristics and require a minimum of maintenance. Transistor switching action is shown in Figures 7A, 7B, and 7C.

The basic converter circuit is shown in Figure 8, which indicates the relative phase and amplitude of the primary and secondary voltages. When power is first applied to the primary circuit, an imbalance will exist between the two transistor circuits due primarily to slight differences in transistor and transformer winding characteristics. This imbalance causes one transistor to momentarily conduct and apply battery voltage across one section of the transformer primary winding, either section A1 or A2 depending upon which transistor is in initial control.

The polarity of the base feedback voltage, with respect to the transformer primary, is such that it drives the "initial control" transistor into very heavy conduction; collector current is several amperes, depending upon the load on the Power Supply output. Degeneration causes the other transistor to be cut off completely.

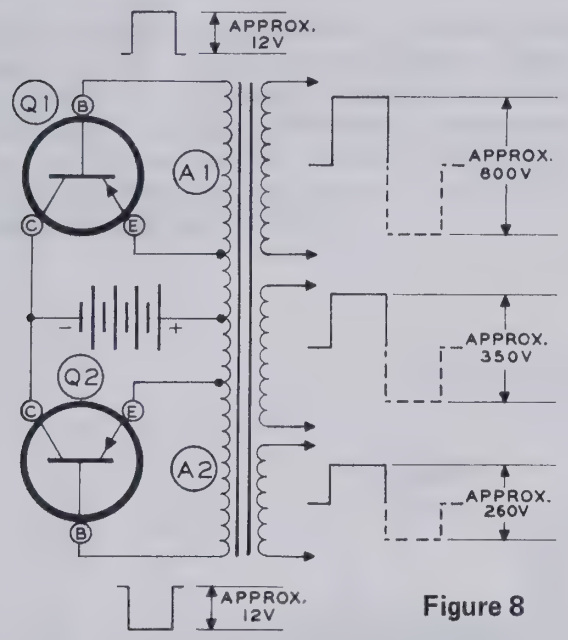


Figure 8

This condition of high current flow will continue until the transformer core reaches saturation. When core saturation occurs, the rate of change of flux approaches zero. The circuit is then unable to maintain the large driving current in the base circuit of the conducting transistor, resulting in a decrease of collector current. This decrease in collector current causes a further decrease of base drive. Circuit feedback is such that continued reduction of base drive causes the conducting transistor to stop conducting (switch off), and the other transistor to begin conducting (switch on).

As the primary circuitry is symmetrical, the operation of the second transistor is identical to that of the initial control transistor. The conditions are duplicated, causing resaturation of the transformer core. This rapid change in core saturation induces a square wave alternating voltage in the transformer secondary windings, in proportion to the turns ratio between the primary and secondary. The cycle will continue to repeat itself and produce the necessary high voltage AC in the transformer secondary windings.

The transistors operate at a nominal switching frequency of 1500 Hz. This frequency represents a good compromise of efficiency, filtering, and operating temperatures. At higher frequencies, the time required for the transistors to switch on and off is a large portion of the operating cycle; this results in low efficiency. At lower frequencies, larger value filter capacitors would be required and a much larger transformer would be needed. The switching frequency is determined by a number of factors, including transistor circuit values, and transformer and transistor characteristics.

The transformer used in this Power Supply is a very efficient toroid type, designed to operate at a frequency of approximately 1500 Hz. The transformer will run relatively warm even under no load. This condition is normal for a transformer operated near or in a saturated condition.

Transistors used in this type of switching application operate at high current during one-half of each cycle. The transistor heat which occurs is effectively dissipated by radiation from the heat sink assemblies, which are cooled by air circulating around the heat sink fins.

SECONDARY CIRCUIT

High Voltage Section

The high voltage DC section uses a full-wave voltage-doubler circuit, consisting of diodes D1, D2, D3, and D4 with capacitors C3 and C4. A voltage-doubler circuit produces a DC output of approximately twice the peak value of the alternating voltage available at the secondary winding of the transformer. Diodes D1 and D2 rectify one-half cycle of voltage, and D3 and D4 rectify the other half cycle. On alternate half cycles, capacitors C3 and C4 charge to the approximate value of the AC voltage appearing across the transformer secondary winding. The polarity is such that the DC voltages developed across these two capacitors add together; this "doubled" DC voltage appears between ground and the junction of D4, C3, and R3. Capacitors C3 and C4 with resistors R3 and R4 provide filtering. R3 and R4 also act as bleeder resistors to provide a discharge path for the voltage doubler capacitors when the power supply is turned off.

Buffer capacitor C2 absorbs transient voltage surges that occur in the secondary winding as a result of transistor switching action in the primary circuit.

Low Voltage Section

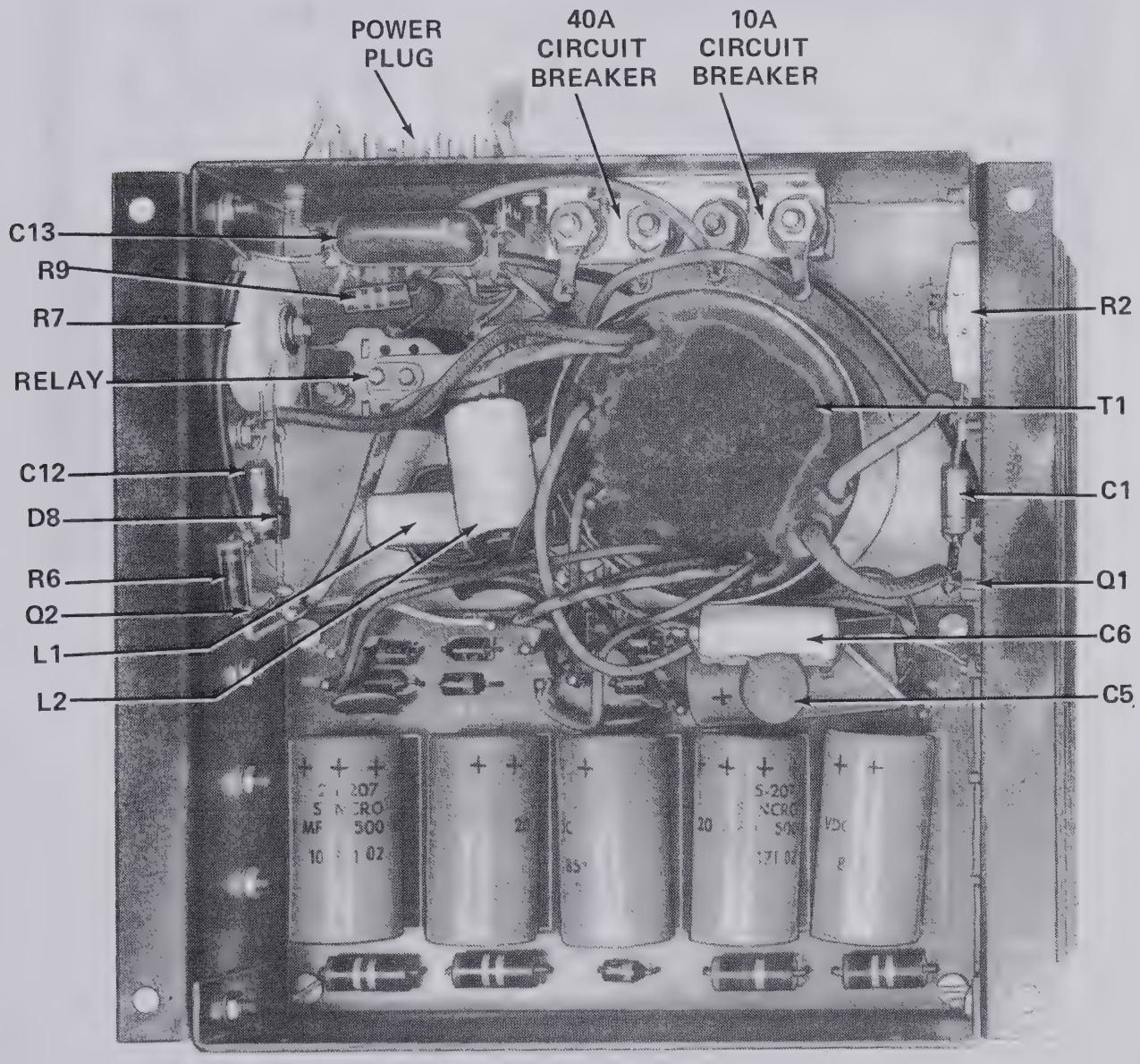
The low voltage DC section also uses a fullwave voltage-doubler circuit, made up of diodes D5 and D6 with capacitors C8 and C10. Capacitors C8, C9, and C10 with choke L1 filter the DC output voltage, which is then applied to the Power Supply connector. R5 is a bleeder resistor, and C7 is a buffer capacitor.

The low voltage secondary winding is tapped to provide a choice of two different output voltages. Either the blue-green or the blue-yellow transformer lead may be connected to the voltage-doubler circuit. The blue-green lead provides the higher output voltage. The choice of output voltages depends on the requirements of the equipment with which the Power Supply is used.

Bias Section

The bias voltage section uses diode D7 as a half-wave rectifier. The filter network consists of capacitors C11A and C11B with resistor R8. Resistor R9 is a bleeder resistor.

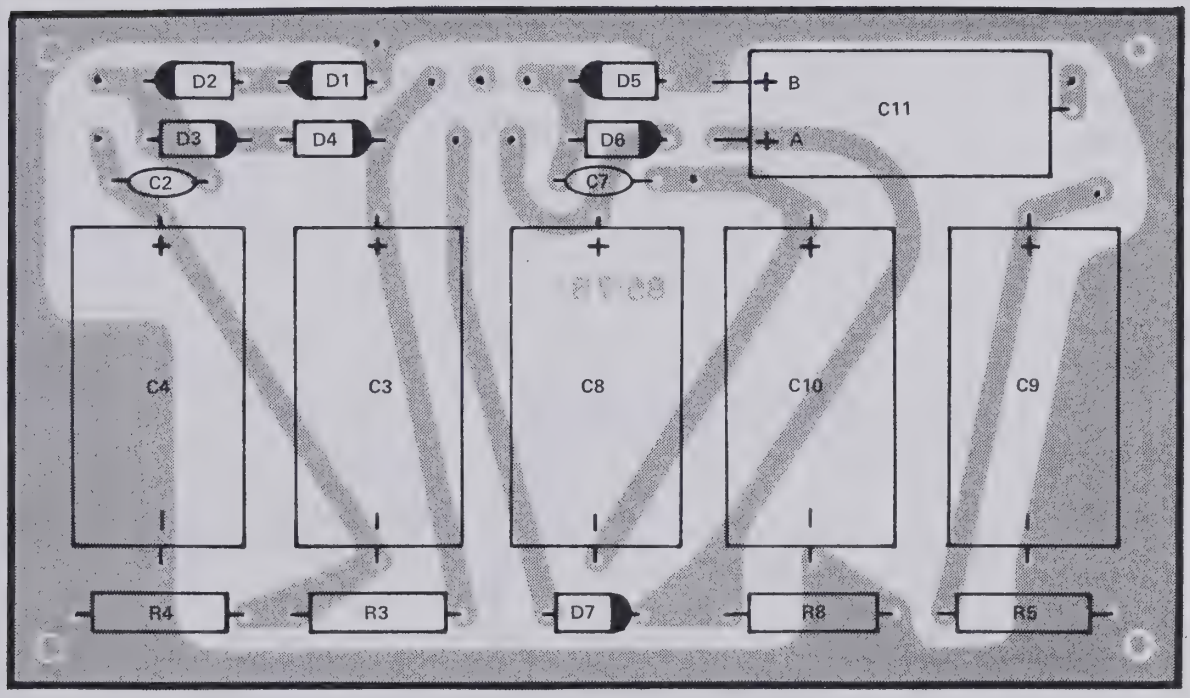
CHASSIS PHOTOGRAPH



X-RAY VIEW

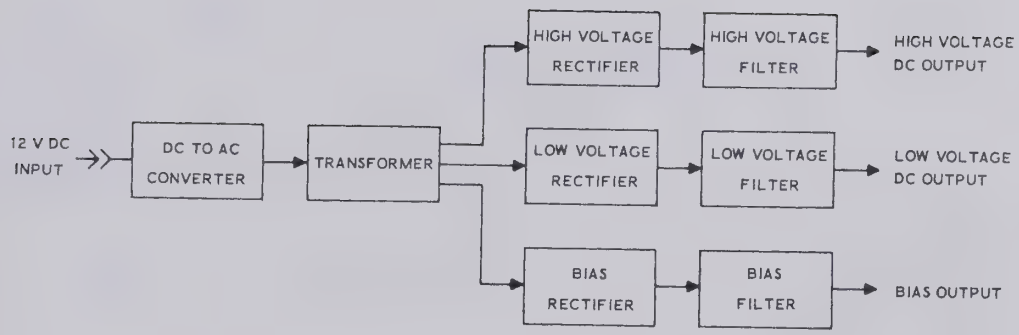
NOTE: To identify a part shown in one of these Views, so you can order a replacement, proceed as follows:

1. Note the identification number of the part (R-number, C-number, etc.).
2. Locate the same identification number (next to the part) on the Schematic. The "Description" of the part (for example: 22 kΩ, .05 μF, or 2N2712) will also appear near the part.
3. Look up this Description in the Parts List.



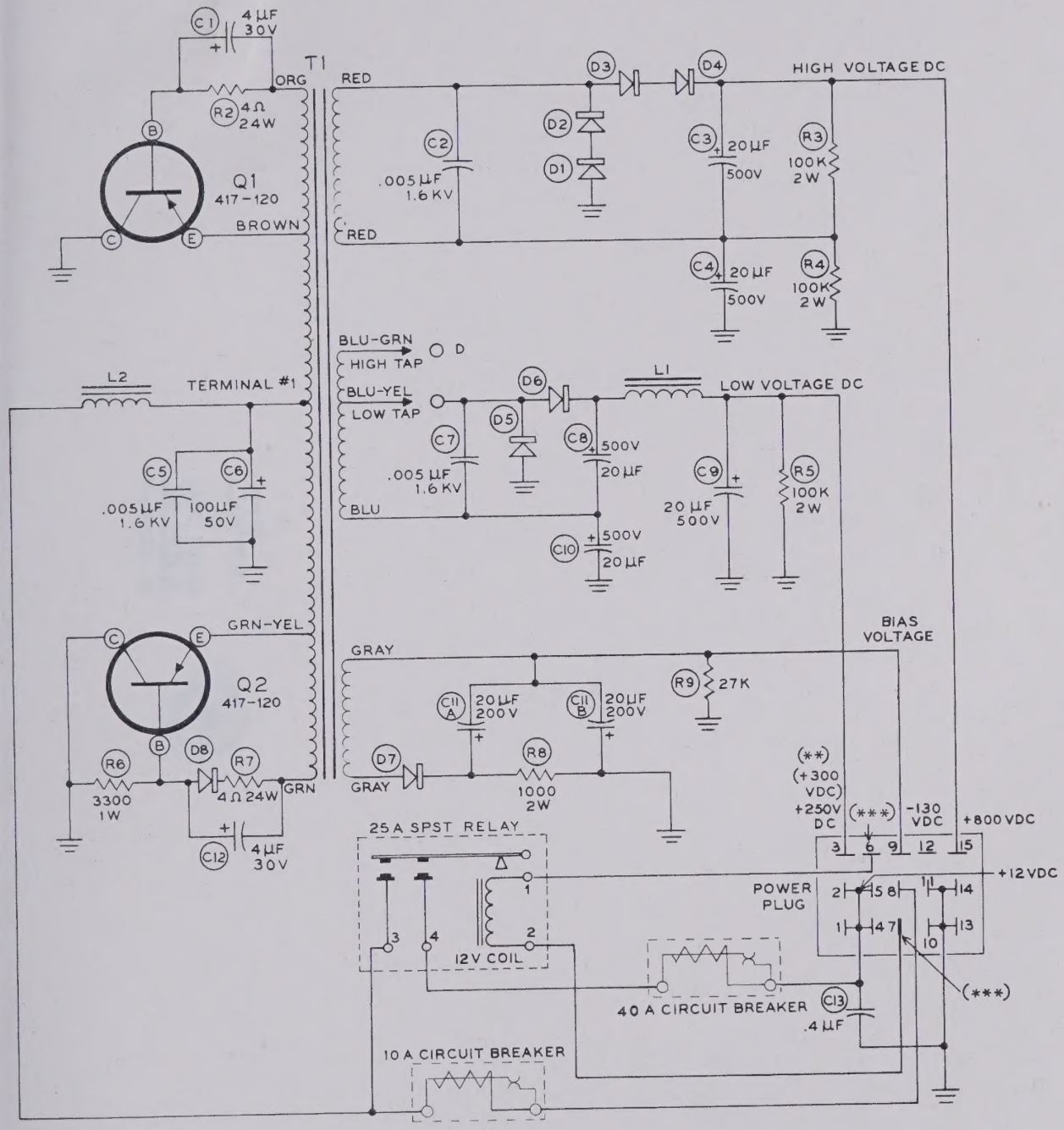
(Shown from component side)

SCHEMATIC OF THE
HEATHKIT®
TRANSISTORIZED
DC POWER SUPPLY
MODEL HP-13B



BLOCK DIAGRAM

A N



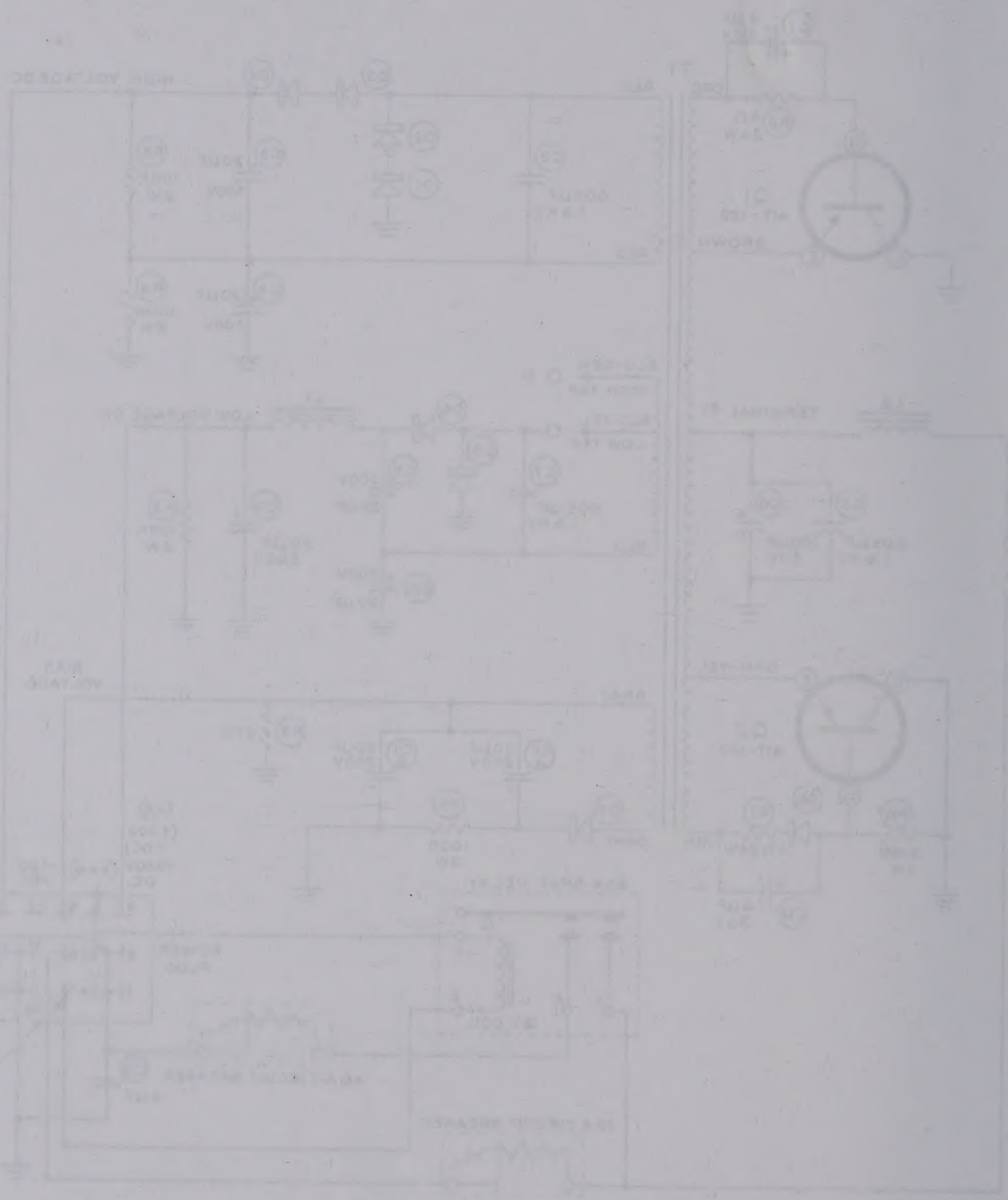
SISTANCES IN OHMS (K=1000, M=1,000,000).

LTAGES MEASURED FROM INDICATED POINT TO CHASSIS D.

PLUG TERMINALS VIEWED FROM INSIDE OF CHASSIS. R LETTER-NUMBER DESIGNATIONS SHOWN ON CHASSIS GRAPHS AND CIRCUIT BOARD X-RAY VIEW.

(* *) +250 V DC LOW TAP.
+300 V DC HIGH TAP.

(***) LUG #6 AND/OR LUG #7 MAY HAVE 12 VDC WITH RESPECT TO GROUND, DEPENDING UPON THE SPECIFIC CIRCUITRY AND CONNECTIONS OF THE EQUIPMENT USED WITH THE POWER SUPPLY.



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